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January 29, 1986
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Mr. James L. Hogeboom
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P.O. Box 6561
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PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Dear Jim:

Woodward-Clyde Consultants is pleased to submit our report on the hydrogeologic investigation of the Philadelphia Coke Plant site. The report covers topics of hydrogeologic regime, groundwater quality and soil chemistry. The work described in this report was performed with the objectives of evaluating existing conditions, maintaining regulatory compliance, and achieving final site closure.

Based on the available data, WCC believes that the pathway to achieving site closure includes additional investigations, possible site remediation and some negotiation with regulatory agencies. Our current aim is to balance these three factors to proceed in a cost-effective manner.

If you have any questions above this report, please do not hesitate to call.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

Peter R. Jacobson

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1.0 INTRODUCTION

Philadelphia Coke Company, Inc. had operated a coke production facility from January 1929 to their permanent closing in March 1982. The 63 acre site is located in the City of Philadelphia and situated along the western bank of the Delaware River, bounded by Buckius, Orthodox, and Richmond Streets (Figure 1-1). The plant used bituminous, and to a lesser extent anthracite coal, to produce foundry coke. The coking process produces a number of coal by-products and derivatives. The major by-product, decanter tar sludge from coking operations, is a Resource Conservation and Recovery Act (RCRA) listed hazardous waste. Figure 1-2 illustrates the configuration of plant facilities and the locations where coke related products and wastes were produced and stored.

Woodward-Clyde Consultants (WCC) has conducted a hydrogeologic investigation for the Philadelphia Coke Company to assess subsurface geologic, groundwater flow, and soil/groundwater quality conditions at their Philadelphia Plant. This study has been performed as part of decommissioning procedures, and in accordance with a formal Closure Plan approved by the Pennsylvania Department of Environmental Resources (PADER). Prior to WCC's involvement in this project, the hazardous waste management facilities at the plant were taken out of operation and measures were followed, in accordance with the closure plan, to remove hazardous materials and contaminated soils. All materials removed from the plant facilities were disposed of off site (appropriately manifested).

The primary purposes of WCC's study are: 1) to evaluate the degree of contamination and document the presence or absence of residual hazardous materials in the subsurface near previous hazardous waste facilities at the plant; and 2) to assess groundwater quality in the water-table aquifer at the plant. These efforts have been performed with the overall objective of achieving a site closure acceptable under RCRA and maintaining the regulatory requirements prior to final closure certification. All work items performed conform to groundwater and soil sampling programs approved by PADER in March 1985 and August 1986, respectively.

2.0 SITE INVESTIGATIONS

This section of the report describes field activities conducted to delineate subsurface conditions at the Philadelphia Coke Plant. Section 2.0 has been divided into five subsections: Monitoring Well Installation (2.1), Soil Sampling (2.2), Groundwater Sampling (2.3), Water Level Measurements (2.4), and Single-Well Permeability Testing (2.5). Data and interpretations from these field activities are presented in subsequent sections.

2.1 MONITORING WELL INSTALLATION

Information concerning the groundwater conditions was derived from water level measurements and groundwater samples obtained from monitoring wells installed by WCC at the plant. A total of six monitoring wells were installed across the plant (Figure 2-1). Each of the monitoring wells were installed in the upper water table aquifer. The upper aquifer, which is comprised of miscellaneous fill, gravel, sand and silt, extends from the ground surface to a confining, and relatively impermeable organic silty clay layer at a depth ranging from 1 to 14 feet below grade.

The present groundwater monitoring system was emplaced in two stages. The first four monitoring wells, W-1 through W-4, were installed in March 1985. One of the wells, W-4, was installed in an area believed to be on the upgradient side of the site; while the other three monitoring wells were located so as to monitor groundwater quality near potential sources of contamination. In October 1986, two additional monitoring wells, W-5 and W-6, were installed. These latter wells were installed to better define the local groundwater flow regime between W-2 and W-4. They also serve to evaluate the potential hydraulic effect that industrial and/or sanitary sewers in the area of W-4 may have on groundwater flow.

Emplacement of monitoring wells was accomplished using hollow-stem auger borehole advancement techniques. During drilling, the soils were sampled at regular intervals to provide information on the subsurface conditions. Continuous soil samples were obtained by advancing a split-spoon sampler ahead of the auger flights. The samples were geologically described by an on-site WCC geologist supervising drilling activities. Prepared geologic logs describing the soils encountered in each borehole are included in Appendix A. Headspace analyses were performed on soil samples collected from the boreholes in the field using a Century Organic Vapor Analyzer (OVA) Model 128 or HNU. This technique aided in the field screening of soils for possible organic contamination. Results of these headspace analyses are provided on the boring logs.

Once the borehole had been advanced to the desired depth, the monitoring well was installed through the auger flights, which keep the hole from collapsing. The auger flights were then slowly raised as appropriate amounts of filter pack, bentonite seal and grout were placed in the hole and allowed to settle around the monitoring well screen and riser pipe. Once emplaced, a raised, steel protective casing was securely emplaced into the cement grout around the PVC riser pipe. The design specifications of a typical monitoring well are shown in Figure 2-2. Monitoring well completion data for all wells is summarized in Table 2-1. A complete description of monitoring well design specifications is included in Appendix B.

All drilling and sampling equipment were carefully decontaminated between well installations to minimize the potential for cross-contamination. All downhole equipment (auger flights, rods, spoons, etc.) were steam-cleaned following an alconox and acetone rinse.

2.2 SOIL SAMPLING

A soil sampling program was undertaken in October 1986, to evaluate the effectiveness of previous site clean-up activities. The soil sampling program was preliminary in that it was only designed to detect the presence or absence of contaminants, not quantify or delineate the extent of contamination. The soil sampling program targeted sample collection from five general locations across the plant:

1. Decanter tar bottoms area
2. Tar plains
3. Lime pit
4. Waste liquor pit
5. Plant background

Individual sample collection points are shown in Figure 2-3.

For the sample locations in the tar decanter area, lime pit, and waste liquor pit, soil samples were obtained from borings. The boreholes were advanced using hollow-stem auger techniques and soil samples taken using split-spoon samplers. Surface soil samples collected from the tar plains and background area were obtained using hand tools. All soil borings, as in monitoring well installation, were visually logged by an on-site WCC geologist as described in Section 2.1. Prepared geologic logs for borings in the soil sampling program appear in Appendix A.

A total of 18 soil samples were collected for laboratory analyses. Table 2-2 summarized sample locations and sample depth intervals. All samples were submitted to Compuchem Laboratories, Inc., Research Triangle Park, North Carolina for analyses of United States Environmental Protection Agency (USEPA) priority pollutant organics (volatiles, acid extractables, base/neutral extractables). Analytical results for the soil samples are presented in Section 5.2, Soil Quality Results.

2.3 GROUNDWATER SAMPLING

In the assessment of groundwater quality at the Philadelphia Coke Plant, seven quarterly rounds of groundwater samples were collected from April 1985 through October 1986. Samples were collected from the four originally installed monitoring wells, W-1 through W-4 by a WCC sampling crew. Samples were analysed by RMC Environmental Services, Pottstown, Pennsylvania for the parameters listed in Table 2-3. All sampling procedures and methodologies are documented in the Groundwater Sampling and Analyses Plan submitted by WCC March 4, 1985, and approved by the PADER on September 12, 1985.

The following is a brief summary of sampling procedures used. Upon completion of drilling, each of the new wells were developed to remove fines and any influences from drilling of the well. The wells were then allowed to stabilize for a 2-week period to allow equilibration of the groundwater flow system. Before collection of all groundwater samples, three well volumes were removed from each well to permit sampling of fresh formation fluid. Removal of groundwater from the wells was accomplished by bailing with stainless steel bailers. All equipment used during development and purging activities was steam-cleaned between wells to prevent cross-contamination. Sampling was performed using a high degree of quality assurance/quality control. Field blanks taken during each quarter were taken from stainless steel bailers after decontamination. Trip blanks were also taken for each quarter of sampling. All samples were carefully taken, preserved, placed on ice, and transported to the laboratory. A complete chain-of-custody record was maintained for each sampling round. A presentation and interpretation of all quarterly groundwater analytical results is presented in Section 5.1, Groundwater Quality.

2.4 WATER LEVEL MEASUREMENTS

All of the site monitoring wells were surveyed by a licensed surveyor to determine the top of well casing elevation, ground elevation, and coordinate location. Elevations were based on USGS National Geodetic Vertical datum or mean sea level. Groundwater elevations were then measured from this datum. Monitoring well locations were correlated to a plant specific coordinate system.

Water level measurements were taken on eight different occasions from April 1985 through October 1986. Water level measurements were also taken at different times during the day to evaluate aquifer responses to tidal fluctuations in the Delaware River. Interpretation and discussion of groundwater elevation results are presented in Section 4.2, Groundwater Flow Conditions.

2.5 SINGLE-WELL PERMEABILITY TESTS

Single-well permeability tests (slug tests) were performed on 5 monitoring wells at the site. One well, W-4, could not be tested because of insufficient water depths in the well. The slug test was performed by inserting a known volume (the slug) into the monitoring well and observing the water level rise and fall after the slug was inserted and removed. The slug test was used to estimate the hydraulic conductivity of aquifer materials and give an indication of groundwater flow rates. The tests were performed using the methodology set forth by Cooper et al. (1967) and Bouwer and Rice (1976).

WCC performed the slug tests using a Druck 10-psig pressure transducer coupled to an Esterline Angus portable strip chart recorder. The transducer was lowered to the bottom of the monitoring well and a slug of known volume inserted below the water level. The slug was then removed "instantaneously" causing a rapid drop of the water level in the well. The transducer measured this instantaneous drop and subsequent rise of the water level to an equilibrium position. The rate at which the water level returns to equilibrium is a function of the hydraulic conductivity. One limitation to this method is that the calculation of hydraulic conductivity only estimates the conditions in the near well vicinity. Also, the calculation should be considered accurate within an order of magnitude.

Table 2-4 presents the slug test results. Hydraulic conductivity was found to range from a low of 1.3×10^{-3} cm/sec in W-3 to a high of 5.8×10^{-2} cm/sec in W-6 with an average of 5.1×10^{-3} cm/sec. A discussion of hydraulic conductivity results is presented in Section 4.1, Groundwater Flow Conditions.

3.0 GEOLOGIC CONDITIONS

The Philadelphia Coke Plant site lies along the westernmost margin of the Atlantic Coastal Plain Physiographic Province (Figure 3-1). Topographically, the Coastal Plain region is characterized by a relatively undiversified lowland. Geologically, the Coastal Plain of southeastern Pennsylvania is underlain by a wedge of unconsolidated sediments which thicken in a southeasterly direction (Figure 3-2). The unconsolidated sediments are in turn underlain by crystalline bedrock. The Coastal Plain deposits are composed of gravels, sands, silts, and clays which range in age from Early Cretaceous to recent. This wedge of Coastal Plain sediments range in thickness from a thin film at the fall line (edge of the Coastal Plain) to over 6000 feet beneath the mouth of Delaware Bay.

Site specific subsurface information at the plant was obtained from two separate sources; WCC logs of soil borings and monitoring wells, and historic test borings provided by Philadelphia Coke Company. The plant subsurface is characterized by a sequence of sand and fill materials underlain by a geologically recent silty clay alluvium layer, a lower sand and gravel deposit of questionable age, and an Early Paleozoic Crystalline bedrock. WCC subsurface information is limited to the upper fill sequence and the uppermost portion of the silty clay unit. Additional information depicting the lower geologic units beneath the plant were provided by the Philadelphia Coke Company. The borings obtained were performed by Koppers Construction Company in March 1928. Due to the age of these historic borings and the inability to validate the data recorded, all interpretation of the information was approached with caution. The historic borings were only used to illustrate the complete sedimentary package underlying the plant.

The surface deposits found at the plant are comprised of man made fill materials (cinders, brick, concrete rubble, coal, etc.) and recent sands. There is a wide range of Standard Penetration Resistance (SPR) measured in the surface deposits illustrating the eratic composition and distribution of fill materials within the surface deposits. Figure 3-3 illustrates the location of geologic cross sections at the plant. Cross sections A-A' and B-B' (Figures 3-4 and 3-5) show the distribution of fill materials across the plant. Fill thicknesses range from less than 1 foot in the tar plain area (TP-1) to over 14 feet near W-4.

Underlying the fill materials is a sequence of very soft, gray, silty clays. These relatively impermeable sediments are natural floodplain and channel deposits of the Delaware River. Although WCC borings do not penetrate this layer completely, historic borings (TB-4) indicate a thickness of approximately 20 feet (Figure 3-4). Regional geologic data imply that this alluvium layer is highly variable in thickness.

Underlying the silty clay unit is a sequence of sand and gravel of varying thickness which lies directly on crystalline (mica schist) bedrock. Again WCC borings do not penetrate this unit, and this information is inferred from historic borings and regional data.

4.0 HYDROGEOLOGY

This section of the report describes the local hydrogeology at the plant. Section 4.0 has been divided into two subsections: Groundwater Flow Conditions (4.1) and Hydraulic Effects of Underground Utilities (4.2). Regional hydrologic information suggests that a two-aquifer system exists beneath the plant. However, the present investigation is limited to an evaluation of the upper, water-table aquifer and discussion of the lower aquifer system is based solely on regional information.

4.1 GROUNDWATER FLOW CONDITIONS

In the coastal plain of Pennsylvania, groundwater occurs predominately in the unconsolidated deposits of sand and gravel. The underlying crystalline bedrock is relatively unimportant as a groundwater producer with the exception of localized areas of fracturing and extensive weathering. The unconsolidated deposits typically occur as two distinct water-bearing systems; an upper water-table (unconfined) aquifer or water-bearing unit and a lower confined water-bearing unit. These two hydrologic units are commonly separated by a deposit of fine-grained alluvium, which acts like a confining layer located along the margin of the Delaware River. The confined hydrologic system is characterized by wedge-like deposits of water-bearing sand and gravel interbedded with silt and clay confining units, dipping to the southeast as described in Section 3.0, (Figure 3-2). The upper water-table aquifer is characterized by surficial deposits of variable thickness, consisting of natural sands and gravels deposited by the Delaware River, as well as man-made fill materials. The aquifer has a limited saturated thickness and areal extent. Regional unconfined groundwater flow appears to mimic topography, flowing from the topographically high areas to lower elevations. In the Philadelphia area, groundwater flows southeastward generally toward the Delaware River (Figure 4-1).

Locally at the plant, groundwater flow in the upper aquifer does not conform to regional trends. Figure 4-2 illustrates representative groundwater elevations at the plant. The highest groundwater elevations exist at W-2, the lowest elevations are at W-4 and intermediate elevations at W-1 and W-3. These data initially suggest that groundwater flows away from a centrally high area near W-2 in a northwesterly (W-4) and southerly (W-1 and W-3) direction. The hydraulic gradient between well W-2 and wells W-1 and W-3, approximately 0.004 and 0.003, respectively, is relatively shallow, and the direction of flow in this portion of the plant is consistent with what is expected from regional hydrologic information. In contrast, a much steeper hydraulic gradient (0.01) is present between wells W-2 and W-4 and groundwater flow is reversed from the regional flow direction. These results are inconsistent with the initial premise that W-4 was located hydrologically upgradient of the main plant facility. As a result, and as requested by PADER, two additional monitoring wells were installed between W-2 and W-4 to help resolve the apparent hydrologic anomaly. Subsequent collection of groundwater elevation data revealed a significantly different senario (Figure 4-3). The steep hydraulic gradient initially thought to exist between W-2 and W-4 is actually a localized hydrologic feature. The gradient between W-2 and W-6 is essentially flat (0.0008). Alternately, an extremely steep hydraulic gradient of 0.05 exists between W-5 and W-4. The observed groundwater pattern suggest that a localized hydrologic sink may be controlling flow in the vicinity of monitoring well W-4. This phenomenon will be discussed further in Section 4.2, Hydraulic Effect of Underground Utilities.

Hydraulic conductivities (K) of the upper unconfined aquifer were found to vary over an order of magnitude, from 1.3×10^{-3} cm/sec to 5.8×10^{-2} cm/sec. The range in permeabilities reflect the wide range of fill materials present at the plant.

The Delaware River in the vicinity of the plant displays a tidal range in excess of six feet. Groundwater elevations were monitored over the tidal cycle to observe aquifer response. There is essentially no measurable change in groundwater levels at the plant in response to tidal fluctuations. In an unconfined water table aquifer, the tidal impulse is transmitted by an exchange of water between the river and aquifer. Because the flow of groundwater is significantly slower than the period of the tidal cycle, there is only a minor volume of water exchange and the changes in water levels are correspondingly low. Evidently, tidal effects are dampened out within a few hundred feet of the river bank.

A seasonal variation of groundwater levels is apparent at the plant. Figure 4-4 illustrates the variation of groundwater levels over time. Each well displays the same trend in elevation changes which correlate with available precipitation records. The monitoring wells all record high groundwater levels during October 1985 and April 1986 and lower groundwater levels during the remainder of the monitoring period. This data suggest that the upper aquifer is responsive to recharge or variations in precipitation and evapotranspiration rates.

4.2 HYDRAULIC EFFECT OF UNDERGROUND UTILITIES

As discussed in Section 4.1, anomalous groundwater flow conditions exist in the vicinity of monitoring well W-4. Based on regional hydrologic information, W-4, the farthest plant monitoring well from the Delaware River should be hydrologically upgradient of the remaining monitoring wells. However, the observed groundwater data suggests that W-4 may not be hydrologically upgradient of the plant. Through an addition of monitoring wells between W-2 and W-4, it was determined that the departure from regional flow conditions is a very localized feature in the vicinity of W-4. A number of conditions were considered to possibly contribute to the anomalous flow patterns. These include: (1) variable infiltration rates across the plant, (2) deep foundations or structures restricting groundwater flow, and (3) buried underground utilities acting as groundwater sinks.

A review of plant utilities data reveal a correlation between the anomalous groundwater pattern and a deep industrial city sewer (about 30 feet below grade) known as the Upper Delaware Collecting Sewer. The sewer traverses the plant from east to west across Buckius and Orthodox Streets (Figure 4-5). This long 12-foot-3 inch diameter sewer is a reinforced concrete, brick-lined conduit which traverses the plant within 30 feet of monitoring well W-4. The location of the industrial sewer within the subsurface materials is illustrated in cross section B" - B' (Figure 4-6). The sewer apparently breaches the base of the silty clay unit and is anchored on the sands and gravels of the lower water-bearing unit.

Given the alignment and location of this sewer with respect to monitoring well W-4 and the observed groundwater flow conditions, it seems probable that the industrial sewer acts as a local groundwater sink. Figure 4-6 depicts two interpretations of the groundwater surface between W-5 and W-4. The first interpretation simply incorporates a straight line from one monitoring well to the other implying a strong downward gradient from W-5 to W-4. The alternate, and more likely interpretation takes into account the presence of the industrial sewer and is noted on the cross section as a dashed line with question marks. Given this interpretation, a groundwater sink is created between W-5 and W-4 and groundwater flows toward the sink from the north (W-4) and south (W-5) of the sewer alignment. The location of the inferred groundwater sink is such that although monitoring well W-4 has historically had the lowest groundwater levels at the plant, it can still be considered hydrologically upgradient of the plant because it is likely upgradient of the sink area. These data strongly imply the validity of W-4 to monitor background conditions has not been compromised.

5.0 GROUNDWATER AND SOIL QUALITY

This section of the report presents groundwater and soil quality results from the Philadelphia Coke Plant. Section 5.0 has been divided into the subsections: Groundwater Quality (5.1), Soil Sampling Results (5.2), and Regulatory Water Quality Standards and Guidelines (5.3).

5.1 GROUNDWATER QUALITY

Four on-site monitoring wells were sampled for seven quarterly rounds to assess the groundwater quality in the shallow aquifer. A complete compilation of analytical results is included in Appendix C. Results of the analyses will be discussed separately by major compound group.

Analytical water quality results indicate that groundwater degradation has occurred in the vicinity of monitoring well W-2. Coal tar constituents, both priority pollutant and general inorganic contaminants are ubiquitous in multiple sampling rounds. Monitoring well W-1 displays conditions indicating a more moderately impacted groundwater regime, not nearly as severe as measured in W-2. Priority pollutant groundwater quality in W-1 has actually improved through the 19 month monitoring period. Groundwater quality near W-3 and W-4 is only slightly impacted. W-4 reflects background water quality conditions. Coal tar related priority pollutants were not found in either wells W-3 or W-4 through the monitoring program. Although some general water quality parameters were slightly elevated in W-3 and W-4 during a limited number of sampling rounds, these slightly elevated readings more likely reflect the presence of man-made fill materials used in the area to elevate the site up to current grades rather than plant related activities.

Volatile Organics: Four priority pollutant volatile organics were measured in the groundwater (Table 5-1). The four volatiles compounds detected include; benzene, methylene chloride, toluene, and ethylbenzene. Detection of volatile organics was limited primarily to W-1 and W-2. However, methylene chloride, a possible laboratory contaminant, was detected in all monitoring wells sporadically in a limited number of sampling rounds.

Total volatile organics (TVO), a summation of all priority pollutant volatile organics are compiled in Table 5-2. Elevated levels were detected in monitoring well W-2. In W-2, TVO ranged from a low of not detected in January and October 1986 to a high of 566 ppb in July 1986. TVO concentrations did not appear to follow any trend over time. Figure 5-1 illustrates the distribution of TVO across the plant. The reported TVO values constitute an arithmetic average of data from the seven sampling rounds.

Acid Extractables: Two priority pollutant acid extractable compounds were measured in the groundwater at the plant (Table 5-1). Detection of the two compounds, phenol and 2,4-dimethylphenol, was restricted to monitoring well W-2. Phenol was detected in four of seven sampling rounds and ranged from 21 to 2,710 ppb. 2,4-dimethylphenol was detected in six of seven sampling rounds and ranged from 10 to 27,600 ppb.

A tabulation of total acid extractable compounds per sampling round is listed in Table 5-3. Figure 5-2 shows the distribution of total acid extractables across the plant. Again, detection of acid extractable compounds was limited to monitoring well W-2. During the groundwater monitoring program there was a decline of two orders of magnitude in total acid extractable concentrations. After initial sampling round results of 30,310 ppb total acid extractables, the subsequent rounds ranged from 663 ppb to not detected.

Base/Neutral Extractables: Fifteen priority pollutant base/neutral extractables were detected in the groundwater at the plant (Table 5-1). Four of the base/neutral compounds were detected in only one round of sampling and at relatively low concentrations: Hexachloroethane (83 ppb), nitrobenzene (90 ppb), bis(2-chloroethoxy) methane (15 ppb), and 2,6-dinitrotoluene (10.6 ppb). These compounds were only detected in W-2. One compound, bis(2-ethylhexyl)phthalate was detected in low concentrations (<12 ppb) in each of the four monitoring wells. This compound is a constituent of polyvinylchloride (PVC) well casing and screen materials. Nine base/neutral compounds, common coal tar constituents, were detected in W-1 and W-2 in quantifiable concentrations. In W-1, six of the nine coal tar related base/neutrals were detected, but in no more than two sampling rounds and in low to moderate concentrations. They include: Acenapthene (84 ppb), phenanthrene (13 ppb), anthracene (10 ppb), fluoranthene (21 ppb), pyrene (9 and 11 ppb), and benzo(a)anthracene (7 ppb). All nine constituents were detected in W-2 in most sampling rounds.

A summary of total base/neutral extractable compounds is listed in Table 5-4. Figure 5-3 illustrates the distribution of total base/neutral extractables across the plant. Coal tar related base/neutral extractables were only detected in W-1 and W-2. A reduction of base/neutral compounds during the monitoring program was apparent in monitoring well W-1. After a high concentration of 127 ppb in June 1985, concentrations decreased steadily through the next two sampling rounds and have been undetected during the last three sampling rounds. Monitoring well W-2 did not display such a trend. Concentrations were variable throughout the monitoring period ranging from a low of 105 ppb to a high of 1,448 ppb.

Water Quality Parameters: Initially, 33 parameters were selected to help characterize groundwater quality (Appendix C). The 33 parameters were assembled from a combination of general water quality, USEPA Appendix II, and additional inorganic parameters. After a review of data through the first two sampling rounds, many of the Appendix II and inorganic parameters not detected were removed from the list following PADER authorization. The parameters removed from the list of analyses include: aluminum, arsenic, barium, mercury, selenium, silver, 2,4-D, 2,4,5-TP, lindane, endrin, methoxychlor, and toxaphene.

Water quality parameters such as Total Dissolved Solids (TDS), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) provide an overall indication of general groundwater quality. Groundwater in the vicinity of W-2 has been impacted as evidenced by the elevated concentrations of screening parameters.

TDS ranged from 1,710 to 5,290 ppm in W-2, indicating a significant volume of inorganic species dissolved in the groundwater. BOD and COD were also elevated (7.9 to 515 ppm and 304 to 1,856 ppm, respectively), evidence that there is organic contamination present. Results from monitoring well W-1 depicted more moderately impacted groundwater quality. Measurements of TDS (1,070 to 2,830 ppm), BOD (0.9 to 42 ppm), and COD (14.5 to 573 ppm) were elevated, but lower than W-2 results. Water quality results from W-3 and W-4 suggested limited contamination. Measurements in W-3 for TDS (252 to 921 ppm), BOD (0.9 to 17 ppm), and COD (10 to 57 ppm), and in W-4 for TDS (108 to 1,405 ppm), BOD (1 to 37 ppm), and COD (7 to 269 ppm) were typically lower than results from both W-1 and W-2.

Parameters including pH, total organic carbon (TOC), specific conductance, and total organic halogens (TOX) were used as indicators of groundwater contamination. pH varied from 5.89 in W-4 to 8.31 in W-2. TOC was quite variable in all monitoring wells. The wide range in TOC may reflect the high organic content of the silty clay confining unit and as such may not be an accurate indicator of contamination. For unknown reasons, TOX results were also extremely variable through the monitoring program within each well. High values of specific conductance indicate the presence of dissolved constituents in the groundwater correlating with TDS values. Specific conductance ranged from a high of 11,100 umhos/cm in W-2 to a low of 158 umhos/cm in W-4.

Chlorides, iron, manganese, phenols, sodium, and sulfates are a group of parameters selected to indicate overall groundwater quality. Monitoring well W-2 had the highest concentrations for chloride (1,990 ppm), phenols (36.9 ppm), sodium (430 ppm), and sulfate (3,650 ppm). W-1 reported highest concentrations for iron (49 ppm) and manganese (12 ppm). Analytical results for monitoring wells W-3 and W-4 showed significantly lower concentrations through all seven sampling rounds. One exception occurred at W-4, during the second sampling round sodium (184 ppm) and chloride (152 ppm) were elevated. These concentrations dropped off rapidly in subsequent sampling rounds.

The remaining Appendix II parameters, chromium, fluoride, nitrate, and coliform bacteria; and additional inorganic parameters, alkalinity, ammonia, and cyanide were used to further define groundwater quality. Chromium and cyanide were of particular interest because they are direct by-products of the coking process. Chromium concentrations were elevated only in monitoring well W-2 (0.05 ppm). Elevated concentrations of cyanide were detected in W-1 (38 ppm) and W-2 (339 ppm). Cyanide concentrations in W-3 were consistently low (0.001 to 0.057 ppm); in contrast to W-4 which displayed an eratic variation of cyanide concentrations over time (0.002 to 16.8 ppm). The remaining parameters; fluoride, nitrate coliform, alkalinity, and ammonia were only elevated in W-1 and W-2. One notable exception was coliform bacteria in W-4 which was detected at >2400 colonies/100 ml in two quarters during the monitoring program.

5.2 SOIL SAMPLING RESULTS

Results from the October 1986 sampling program are presented in this section. An incorporation of analytical soil chemistry results and field observations are utilized to assess overall soil quality and the effectiveness of prior remedial measures implemented at the plant. Soil boring logs from the sampling program are given in Appendix A. The results are presented by specific plant area as specified in Section 2.2, Soil Sampling.

Decanter Tar Bottoms Area: The decanter tar bottoms area is located in the central portion of the plant (Figure 5-4). The area consists of two concrete lined pits, 10 feet wide, 12 feet long, and 8 feet deep and an earthen lined lagoon, 15 feet wide, 75 feet long, and 8 to 10 feet deep. The pits were used to store tar wastes from the coking process. Seven shallow borings were drilled in this area to assess the effectiveness of the waste removal program.

Five borings were used to characterize lagoon materials; three borings spaced equidistant inside the lagoon (B-1 to B-3) and two borings directly outside the lagoon (B-6 and B-7). Figure 5-5 depicts a cross section through the lagoon area showing boring location, sample intervals, lagoon dimensions and subsurface conditions. The silty clay layer was encountered in all borings ranging in depth from 6 to 9 feet. Within the lagoon itself the clay surface dips to the west from B-3 to B-1. All borings within the pit display evidence of contamination. Evidence including elevated organic vapor readings, strong odor, and visible staining of fill materials suggest that some tar materials are present. The two borings outside the lagoon area also display evidence of contamination, though to a lesser extent. Two borings were also used to characterize material within the two concrete lined pits (B-4 and B-5). In each of these borings, the bottom of the pit was not encountered indicating that either the borings were drilled just outside the pit, or that the concrete bottom had been removed during remediation of waste materials. However, contamination in the form of strong odors, elevated organic vapor concentrations (measured on the HNU) and an oily sheen on the soils was apparent in both borings. In addition, boring B-5 encountered a viscous, black, tar-like material at a depth of 11 feet.

Analytical results confirm the field observations. A total of 22 priority pollutant organics were detected in the decanter tar bottoms area (Table 5-5). The volatiles and acid extractables detected (4 and 2 constituents respectively) constitute only a small portion of total compounds detected. The majority of soil contamination is attributed to the 15 coal tar related base/neutral extractables detected. A distribution of total base/neutral extractable compounds within the lagoon area is illustrated in Figure 5-6. Note in the cross section that samples within the fill materials inside the lagoon contain the highest concentrations (62,100 to 568,100 ppb) of total base/neutrals. Outside the lagoon within the fill materials, base/neutral concentrations decline substantially (2,420 to 16,530 ppb). Additionally, samples at the fill/clay interface or slightly into the clay unit also show a decline in contamination (one to two orders of magnitude) compared to samples entirely within the fill unit. Samples from within the concrete lined pits also show significant base/neutral contamination. The sample from boring B-5 where the tar material was encountered reports the highest concentration of total base/neutrals detected at the plant (2,229,200 ppb).

Tar Plains Area: The southwestern corner of the plant, referred to as the tar plains area, was utilized as a disposal area for both nonhazardous debris and waste tar materials (Figure 5-4). Three soil samples were taken from the tar plains to evaluate waste removal efforts. Sample locations were selected randomly from a nine node grid set up over the area as requested by PADER. The soil samples, taken using hand tools, were composited over the 6 to 18 inch depth interval at each location. Subsurface materials in tar plain excavation TP-1 showed significant signs of contamination including staining of soils, oily sheen of materials and strong odors. In tar plain samples TP-2 and TP-3, visual evidence of contamination was not readily apparent.

Tar plains analytical results reveal that again contamination is largely restricted to coal tar related base/neutral extractables. Acid extractables are not detected, and volatile organics limited to low levels ($<$22 ppb of methylene chloride, toluene and benzene). Fourteen of the sixteen coal tar related base/neutrals detected at the plant are present in the three tar plain samples (Table 5-5). The distribution of total base/neutral extractables in the tar plain samples is consistent with field observations of soil materials. Soil sample TP-1 which showed field evidence of contamination also possessed the higher concentration of base/neutral compounds (1,131,500 ppb). The soil samples collected from TP-2 and TP-3 did not display visual signs of contamination and have total base/neutral concentrations several orders of magnitude lower than TP-1 (5,050 and 14,610 ppb, respectively).

Lime Pit: The lime pit area, along the western boundary of the plant, adjacent to Orthodox Street, was evaluated with one boring, B-9, located as shown in Figure 5-4. The boring was advanced to a depth of 10 feet. From 0 to 5 feet, a mixture of dry sand and fill materials were encountered. At a depth of 5 feet, a resistant layer 16 inches thick, of white to gray cemented sand sized material was encountered. This cemented material was probably a layer of calcium oxide. Below a depth of 5.5 feet the water table was encountered and the subsurface materials appeared stained and had a strong odor. Soil samples for chemical analysis B-9A and B-9B were taken at depths of 4 to 6 and 8 to 10 feet, respectively.

Results of priority pollutant volatiles, acid, and base/neutral extractable analyses indicate the presence of base/neutral extractable contamination. All sixteen coal tar related base/neutral compounds are detected in the two lime pit soil samples (Table 5-5). Total base/neutral concentrations of 102,940 ppb (B-9A) and 51,520 ppb (B-9B) are reported. Additional priority pollutant compounds detected are reported at significantly lower concentrations; phenol (570 ppb), benzene (10 ppb), and toluene (5 ppb) in sample B-9B.

Waste Liquor Pit: The waste liquor pit, a concrete lined rectangular pit was used as a storage area for tar sludges, acids, and spent solvents. A single boring B-8 was located two feet outside the southeast wall of the pit (Figure 5-4). The boring was advanced to a depth of 12 feet. At the water table (6.5 feet) the sediments were stained and had a very strong odor. The silty clay unit was encountered at a depth of approximately 9 feet. A soil sample for chemical analyses was taken at the 8 to 10 feet depth interval.

Analytical results for soil sample B-8A reveal contamination restricted to base/neutral extractable compounds. Fifteen of the sixteen coal tar related base/neutral compounds are detected (Table 5-5). A total base/neutral extractable concentration of 57,190 ppb is reported.

BACKGROUND: A single background sample BG-1 was located in the northwest corner of the site, removed from the plant facilities. The sample was taken using hand tools and composited over the 6 to 12 inch depth interval. Soils encountered were dry medium brown sandy silts with no visual sign of contamination.

The background sample shows detectable concentrations of base/neutral compounds. Eleven of the sixteen coal tar related compounds are present in the sample (Table 5-5). The total base/neutral extractables concentration is reported at 8,950 ppb.

5.3 REGULATORY WATER QUALITY STANDARDS AND GUIDELINES

The water quality quidelines discussed in this section were valuable for comparative purposes and helped to evaluate overall plant groundwater quality. However, it should be emphasized that these guidelines are for drinking water standards and the upper aquifer in the vicinity of the plant is used neither as a source of drinking water, nor an industrial well supply.

Currently, there are groundwater quality standards for only a limited number of compounds. Environmental regulatory agencies in the Commonwealth of Pennsylvania presently defer to the federal standards and guidelines which are found in several regulatory publications: U.S. Environmental Protection Agency Water Quality Criteria (U.S. EPA, 1980); National Interim Primary Drinking Water Standards (40 CFR Part 265 Appendix III, July 1, 1985); EPA Secondary Drinking Water Standards (40 CFR Part 143, July 1, 1985); and Recommended Maximum Contaminant Levels (Federal Register, Vol. 50, No. 219, November 13, 1985).

The National Primary and Secondary Drinking Water Standards set maximum contaminant levels for organic and inorganic contaminants in community water systems. These standards are shown in Table 5-6. The primary standards were established based on human health effects; whereas, the secondary standards are based on taste and odor concerns.

During collection of seven rounds of water quality samples, results indicate that proposed guidelines for primary and secondary drinking water parameters were exceeded for nine parameters at the plant. Of these nine parameters, three were primary drinking water standards; the remainder being only secondary (non-health effect) guidelines. Fluoride concentrations in W-2 exceeded the primary drinking water standard during five sampling rounds. Similarly, W-2 had chromium concentration above primary guidelines during one sampling round. Cyanide concentrations in W-1 (three rounds), W-2 (seven rounds), and W-4 (four rounds) all exceeded prescribed limits.

Secondary Drinking Water Standards were exceeded for iron, manganese, nitrate, total dissolved solids, and sulfate for at least one sampling round in all four monitoring wells. Manganese limits were exceeded in all sampling rounds of each monitoring well.

Table 5-7 illustrates a compilation of water quality criteria for the priority pollutant organics detected at the plant. The compiled guidelines originate from a number of sources. These guidelines include limits from: Ambient Water Quality Criteria, Organoleptic Ambient Water Criteria, Suggested No Adverse Response Level (SNARL), Recommended Maximum Contaminant Level (RMCL), and Maximum Contaminant Level (MCL). The MCL is an enforceable standard and as a result is the desired guideline for comparative purposes. However, for many parameters an MCL is not yet determined so a nonenforceable RMCL guideline is applied. For parameters where neither an MCL or RMCL is available, the remaining guidelines listed above are employed for comparison purposes.

2,4-dimethylphenol was the only acid extractable to exceed guideline concentrations. The limit was exceeded for three sampling rounds in monitoring well W-2. Nine base/neutral extractable parameters exceeded guideline concentrations in one or more sampling rounds. The water quality criteria for many of the base/neutral compounds are extremely low due to their suspected carcinogenic properties. As a result, if the compound is detected at all, it probably exceed the regulatory guidelines. The base/neutral compounds which exceeded set guidelines include: acenapthene, fluorene, phenanthrene, pyrene, and benzo(a)anthracene in W-1 and W-2; and benzo(a)pyrene, fluoranthene, bis(2-chloroethyl)ether, and hexachloroethane in W-2 only. The only priority pollutant volatile of concern was benzene. Benzene concentrations in monitoring well W-2 exceeded Maximum Contaminant Levels in five of seven sampling rounds.

6.0 CONCLUSIONS

The data presented and discussed earlier in this report allow for the development of conclusions and the identification of data gaps, as described below.

6.1 HYDROGEOLOGY

The monitoring well system installed at the Philadelphia Coke site is monitoring groundwater in the shallow unconfined aquifer beneath the plant. This zone is relatively thin, averaging approximately 6-8 feet thick, and is likely the zone most highly impacted by past waste management practices.

Well W-2 is monitoring groundwater in the vicinity of the tar decanter area. Water level data are not adequate to define if W-2 is hydraulically downgradient from the tar decanter facilities, but water quality data indicate that the well monitors groundwater that has been impacted by the facilities.

Well W-4 is monitoring groundwater that represents background conditions; this well is located in the regionally upgradient direction. Water levels near W-4 are apparently locally depressed by the effects of the subsurface sewer line(s) in the area.

6.2 GROUNDWATER QUALITY

Groundwater quality in the shallow zone beneath the plant has been impacted by previous waste management practices. Well W-2 exhibits the highest levels of contamination, with low levels in W-1 and virtually no contamination in W-3 and W-4. As expected from the site history, the contaminants present are components of coal tars and other coke by-products; i.e. most of the organic contamination falls into the base/neutral extractable fraction.

The contamination detected in W-2 has apparently resulted from past storage and handling of waste materials in the tar decanter area. Specific sources in this area would include the former lagoon, the tar decanter pits, and associated piping and tanks in the area. Possible spills and leaks from these facilites have allowed contamination to enter the subsurface.

The importance of other potential sources of groundwater contamination around the site has not been amenable to full evaluation with the existing monitoring system. Well W-1 monitors groundwater downgradient from the tar plains area and shows relatively minor contamination. Other areas of the plant (e.g. the waste liquor pit, lime pit, underground tanks, etc.) are currently not monitored by the existing system.

Based on WCC's understanding of the shallow hydrogeologic system and contamination conditions, it does not appear that the contamination detected in W-2 represents part of a widespread contaminant plume. Although permeabilities in the shalllow system are moderate, the gradients are low, saturated portions of the zone are thin, and the contaminants are relatively slow moving. On the other hand, the fifty years of plant operations allows for some contaminant dispersion. Due to the proximity of W-2 to the tar decanter area, the water quality in that well is probably the worst around the plant; however, the extent of the plume has not been defined. Also, the pathways for migration of contamination to other parts of the plant and potentially to off-site areas have not been defined.

6.3 SOIL CHEMISTRY

The results of WCC's soil boring program indicate that significant levels of contamination remain in the soils at the five areas investigated. In the tar decanter area, the contamination is present as contaminated soils and as waste materials present in the subsurface as a separate phase. In other areas, the contamination of soils is primarily from aqueous wastes and/or leaching of wastes products into the subsurface. Two significant aspects of the contaminated soils should be noted:

1. contaminated soils will continue to be a source of contaminants to the groundwater (although calculations of the leachability of the contaminants have not been made); and

2. the presence of wastes and contaminated soils implies that additional site remediation is warranted (see below).

6.4 ADEQUACY OF PREVIOUS CLOSURE EFFORTS

The basic closure strategy for the solid and hazardous waste facilities at the Philadelphia Coke Plant has been to excavate and remove waste materials for off-site disposal. The PADER-approved closure plan for the site specifies the removal of over 12,000 cubic yards of contaminated materials. Previous removal activities (although not witnessed by WCC) represents the elimination of the vast majority of waste materials from the site. However, the results from the soil boring program indicate that previous efforts were not entirely complete in removing contaminated materials. The closure plan recognized this possibility in specifying that soils in areas surrounding waste facilities should be inspected for contamination. Waste materials are still present in the subsurface at the tar decanter area and contaminated soils are present in all areas investigated.

6.5 CLOSURE REQUIREMENTS

Closure requirements for hazardous waste facilities in Pennsylvania are specified in PADER's Hazardous Waste Management regulations (Chapter 75.265). These regulations require, in part, the following:

1. preparation of and compliance with an approved Closure Plan;

2. preparation of and compliance with an approved groundwater monitoring plan; and

3. closure of the waste management units "... in a manner that minimizes the need for further maintenance, and controls, minimizes or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the groundwater, or surface waters, or to the atmosphere."

Philadelphia Coke's Closure Plan, dated June 1983, detailed the specific waste management units, the types of wastes at the site and the method of closing the facilities. The Plan also specifies that soils adjacent to the waste facilities would be inspected for contamination, a task that was performed by WCC, as described in this report. Although not specified in the Closure Plan, the implication is that if the soils are found to be contaminated, appropriate remedial measures will be taken. The need for remediaton should be based on calculations of risk levels associated with current conditions, as described in Section 6.6.

Remediation may also be warranted for the contaminated groundwater. In accordance with Philadelphia Coke's approved Groundwater Sampling and Analysis Plan, dated March 4, 1985, a Groundwater Quality Assessment and Abatement Program will be implemented. The purposes of this program are to "determine the rate and extent of migration of hazardous wastes in the groundwater" and to perform an "evaluation and assessment of remedial alternatives." The need and methods for groundwater remediation should also be based on risk-level considerations.

6.6 SITE REMEDIATION

Current approaches to hazardous waste sites dictate a risk-based evaluation of remedial alternatives. (Note that "remedial alternatives" include the "no-action alternative.") Balancing cleanup complexity and cost with risks to environmental and human populations recognizes that in most cases, it is not practicable or possible to clean up a site to background conditions; in many cases, even achieving regulatory standards is not feasible. The risk assessment approach is also a means of developing site-specific cleanup standards. A risk assessment considers contaminants, pathways and receptors to evaluate the exposure of off-site populations, if any, to site contaminants. These data are combined with toxicological data to quantify the risks posed by the site, under current conditions or with different remedial schemes.

Site-specific data are not complete enough to date to perform a risk assessment for the Philadelphia Coke plant site. However, preliminary statements can be made, based on existing data, which yield some insight into the level of risk posed by the current conditions:

1. The shallow water-bearing zone is not used for drinking or other water supply in the vicinity of Philadelphia Coke.

2. Groundwater in the shallow zone is relatively slow moving, under shallow gradients; the prime contaminants (coal tar materials) are also relatively slow moving in most soils.

3. The most direct groundwater pathway for potential human exposure is by discharge to the Delaware River and migration to the Torresdale water

intake, approximately 5 miles upstream. (Tidal motions in the river will allow some upstream movement.) During this travel, significant dilution would undoubtedly occur.

4. The base/neutral contaminants detected at W-2 and in the soils around the plant present health concerns at relatively low concentrations, if human or ecological populations are exposed.

5. A deeper aquifer exists within the region beneath the Philadelphia Coke plant site. No wells have been installed at the plant site to determine conditions in that aquifer. Potential exposure pathways in the deep zone are probably different than through the shallow zone.

The importance of the factors listed above, and their interrelationships, are critical to evaluating site remediation needs, but can only be evaluated with a more complete database of on-site information. Specifically, additional data are required to more fully define the pathways, exposure routes, and potential receptors. Hence, the recommendations provided in Section 7.0 of this report are designed to expand the existing database to allow refinement of the risk factors.

7.0 RECOMMENDATIONS

Several recommendations, as listed below, can be directly derived from the work performed to date. These recommendations are based on the dual objectives of maintaining regulatory compliance and better delineating the known contamination. WCC believes that cost-effective site remediation cannot be adequately planned with the existing data.

1. Monitoring of the 4 original groundwater monitoring wells should continue on a quarterly basis. In addition, W-5, W-6, and any new wells (see below) should be monitored semi-annually.

2. For all future monitoring, Philadelphia Coke should petition PADER to allow a reduction in the analytical parameters. The following are the parameters that should be included in future monitoring:

    - o priority pollutant volatiles
    - o priority pollutant acid extractables
    - o priority pollutant base/neutral extractable
    - o chromium
    - o cadmium
    - o manganese

3. Additional shallow wells are warranted to further delineate the contaminant plume near W-2, to evaluate other potential sources, and/or to better define contaminant migration pathways. Aproximately six locations have been tentatively identified - three between W-2 and Orthodox Street, two between W-2 and the river and one location east of W-2.

4. Due to the possibility of contaminant migration downward beneath the clay, water quality in the deeper aquifer should be investigated. Initially one well should be installed (near W-2), but additional deep wells would be required if contamination is detected.

5. Investigation of the tar decanter area is warranted to further delineate soil contamination and tar products in the subsurface. Backhoe pits and soil sampling are recommended to locate the decanter pits and other important features.

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Tables

TABLE 2-1

SUMMARY OF WELL CONSTRUCTION DATA
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Well Number	Completion Date	Total Depth (1) (ft)	Casing Material	Casing Diameter (in)	Type of Screen	Screened Interval (1) (ft)	Top of Casing Elevation (ft) (2)	Ground Elevation (ft) (2)	Coordinates (3) North	Coordinates (3) East
W-1	March 25, 1985	14	PVC	4"	SCH 40 20 SLOT	3-13	10.94	8.7	8,499.01	9,559.42
W-2	March 26, 1985	14	PVC	4"	SCH 40 20 SLOT	3-13	15.31	13.4	9,242.25	9,932.47
W-3	March 26, 1985	14	PVC	4"	SCH 40 20 SLOT	2.5-12.5	14.46	11.5	8,832.18	10,256.92
W-4	March 25, 1985	16	PVC	4"	SCH 40 20 SLOT	4-14	15.17	13.2	9,978.68	9,713.30
W-5	October 23, 1986	16	PVC	2"	SCH 40 10 SLOT	4-14	14.76	12.80	9,886.25	9,729.98
W-6	October 23, 1986	14	PVC	2"	SCH 40 10 SLOT	4-14	14.50	12.90	9,669.25	9,914.97

(1) Screened intervals and depths are in feet below ground surface

(2) Elevations in feet Mean Sea Level (USGS Datum)

(3) Plant coordinate system

Woodward-Clyde Consultants

TABLE 2-2

SUMMARY OF SOIL SAMPLING PROGRAM
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Location	Approximate Depth (ft)	No. of Samples	Sampling Method
Decanter Tar Bottoms Area			
B-1	6, 10	2	HSA
B-2	6, 10	2	HSA
B-3	5, 7	2	HSA
B-4	10	1	—
B-5	8	1	HSA
B-6	8	1	HSA
B-7	6,8	2	HSA
Waste Liquor Pit			
B-8	10	1	HSA
Lime Pit			
B-9	4,8	2	HSA
Tar Plains			
TP1	0.5	1	Hand Tools
TP2	0.5	1	Hand Tools
TP3	0.5	1	Hand Tools
Background			
BG-1	0.5	1	Hand Tools

Note: HSA = Hollow Stem Auger

TABLE 2-3

LIST OF PARAMETERS ANALYZED
GROUNDWATER SAMPLING
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

ORGANIC COMPOUNDS

Volatile Organic Priority Pollutants
Base/Neutral Extractable Priority Pollutants
Acid-Extractable Priority Pollutants

PARAMETERS ESTABLISHING GROUNDWATER QUALITY

Chlorides	Phenols
Iron	Sodium
Manganese	Sulfates

PARAMETERS USED AS INDICATORS OF GROUNDWATER CONTAMINATION

pH
TOC (Total Organic Carbon)
Specific Conductance
TOX (Total Organic Halogen)

APPENDIX II PARAMETERS

Arsenic	Mercury	Endrin
Barium	Nitrate	Lindane
Chromium	Selenium	Methoxychlor
Fluoride	Silver	Toxaphane
Lead	Coliform Bacteria	2,4-D
2,4,5-TP		

ADDITIONAL INORGANIC PARAMETERS

Alkalinity	Total Dissolved Solids
Aluminum	BOD
Ammonia as N	COD
Cyanide	

TABLE 2-4

SINGLE-WELL PERMEABILITY TESTING
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA
OCTOBER 27, 1986

Well Number	Permeability (k) (cm/sec)	Aquifer Conditions
W-1	1.4×10^{-3}	unconfined
W-2	3.5×10^{-3}	unconfined
W-3	1.3×10^{-3}	unconfined
W-4	---	---
W-5	9.5×10^{-3}	unconfined
W-6	5.8×10^{-2}	unconfined

Note: Permeability for W-4 could not be determined due to an insufficient supply of water in the well.

TABLE 5-1

GROUNDWATER QUALITY RESULTS
PRIORITY POLLUTANT ORGANICS DETECTED
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

VOLATILE ORGANICS

Benzene	1.3 - 490.0 ppb
Methylene Chloride	< 1.0 - 9.2 ppb
Toluene	< 0.2 - 81.0 ppb
Ethylbenzene	< 1.0 - 43.0 ppb

BASE/NEUTRAL EXTRACTABLES

Bis(2-chloroethyl)ether	15.0 - 33.0 ppb
Hexachloroethane*	0 - 83.0 ppb
Nitrobenzene*	0 - 90.0 ppb
Bis(2-chloroethoxy)methane*	0 - 15.0 ppb
Naphthalene	< 5.0 - 1180.0 ppb
Acenapthylene	< 7.0 - 56.0 ppb
2,6-Dinitrotoluene*	0 - 10.6 ppb
Acenapthene	8.0 - 84.0 ppb
Fluorene	< 5.0 - 120.0 ppb
Phenanthrene	< 5.0 - 347.0 ppb
Fluoranthene	< 5.0 - 191.0 ppb
Pyrene	< 5.0 - 126.0 ppb
Benzo(a)anthracene	< 10.0 - 25.0 ppb
Benzo(a)pyrene	< 25.0 - 96.0 ppb
Bis(2-ethylhexyl)phthalate	< 5.0 - 12.0 ppb

ACID EXTRACTABLES

Phenol	21.0 - 2710.0 ppb
2,4-Dimethylphenol	10.1 - 27600.0 ppb

*Compound was detected in only one sampling round.

TABLE 5-2

TOTAL VOLATILE ORGANIC CONCENTRATIONS (ppb)
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Well Number	4-10-85	6-26-85	10-15-85	1-23-86	4-24-86	7-29-86	10-10-86
W-1	ND	1.5	9.2*	7.7	4.4*	< 5.0	ND
W-2	212.2	315.1	210.0	ND	93.4	566.2	ND
W-3	3.8*	< 1.0	ND	ND	6.1*	< 5.0	ND
W-4	3.4*	< 1.0	ND	< 1.0	ND	< 5.0	ND

*Only volatile organic detected was Methylene Chloride, a potential laboratory contaminant.

ND - Not Detected

TABLE 5-3

TOTAL ACID EXTRACTABLE CONCENTRATIONS (ppb)
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Well Number	4-10-85	6-26-85	10-15-85	1-23-86	4-24-86	7-29-86	10-10-86
W-1	ND	ND	ND	ND	ND	ND	ND
W-2	30,310.0	276.0	ND	646.0	10.1	663.0	274.0
W-3	ND	ND	ND	ND	ND	ND	ND
W-4	ND	ND	ND	ND	ND	ND	ND

ND - Not Detected

TABLE 5-4

TOTAL BASE/NEUTRAL EXTRACTABLE CONCENTRATIONS (ppb)
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Well Number	4-10-85	6-26-85	10-15-85	1-23-86	4-24-86	7-29-86	10-10-86
W-1	< 10.0	127.2	42.3	5.0	ND	ND	ND
W-2	105.0	360.5	1448.0	635.0	349.6	237.0	1404.0
W-3	12.0*	ND	ND	< 5.0*	ND	ND	ND
W-4	8.5*	5.8*	< 5.0*	5.0*	ND	ND	ND

*Only Base/Neutral Extractable detected was bis(2-ethylhexyl)phthalate, a potenial well material contaminant

ND - Not Detected

TABLE 5-5

SOIL QUALITY RESULTS
PRIORITY POLLUTANT ORGANICS DETECTED
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Parameter	Units	B-1A	B-1B	B-2A	B-2B
Acid Extractables					
Phenol	ppb	1200	BDL	BDL	BDL
2,4-Dimethylphenol	ppb	220	BDL	270	BDL
Total Acids		1420	BDL	270	BDL
Base/Neutral Extractables					
Naphthalene	ppb	81,000	7,800	13,000	250
Acenaphthylene	ppb	17,000	1,900	2,000	BDL
Acenapthene	ppb	BDL	BDL	BDL	BDL
Fluorene	ppb	16,000	2,500	5,600	BDL
Phenanthrene	ppb	33,000	6,400	1,500	220
Anthracene	ppb	7,900	1,300	3,800	BDL
Fluoranthene	ppb	18,000	3,800	8,900	300
Pyrene	ppb	11,000	3,400	8,000	300
Benzo (A) Anathracene	ppb	6,500	1,800	3,700	240
Bis (2-Ethylhexyl) Phthalate	ppb	BDL	BDL	BDL	BDL
Chrysene	ppb	5,800	1,700	3,600	270
Benzo (B) Fluoranthene	ppb	6,500	930	4,800	420
Benzo (K) Fluoranthene	ppb	6,500	1,400	4,800	420
Benzo (A) Pyrene	ppb	3,300	880	2,400	260
Indeno (1,2,3-c,d) Pyrene	ppb	BDL	BDL	BDL	BDL
Dibenzo, (A,H) Anthracene	ppb	BDL	BDL	BDL	BDL
Benzo (G,H,I) Perylene	ppb	BDL	BDL	BDL	BDL
Total Base/Neutrals		212,500	33,810	62,100	2,680
Volatile Organics					
Methylene Chloride	ppb	BDL	BDL	18	BDL
Benzene	ppb	80	BDL	BDL	BDL
Toluene	ppb	50	BDL	BDL	BDL
Ethylbenzene	ppb	84	BDL	BDL	BDL
Total Volatiles		214	BDL	18	BDL

BDL - Below Detection Limit

TABLE 5-5

SOIL QUALITY RESULTS
PRIORITY POLLUTANT ORGANICS DETECTED
PHILADELPHIA, COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Parameter	Units	B-3A	B-3B	B-4A	B-5A	B-6A
Acid Extractables						
Phenol	ppb	910	BDL	360	BDL	270
2,4-Dimethylphenol	ppb	180	BDL	BDL	2600	290
Total Acids		1090	BDL	360	2600	560
Base/Neutral Extractables						
Naphthalene	ppb	52,000	510	4,000	380,000	330
Acenaphthylene	ppb	13,000	BDL	420	BDL	BDL
Acenapthene	ppb	3,900	BDL	1,200	140,000	BDL
Fluorene	ppb	37,000	180	860	140,000	BDL
Phenanthrene	ppb	110,000	780	2,500	410,000	290
Anthracene	ppb	34,000	220	1,700	86,000	BDL
Fluoranthene	ppb	90,000	740	2,400	300,000	300
Pyrene	ppb	55,000	720	1,700	200,000	350
Benzo (A) Anathracene	ppb	36,000	400	1,000	96,000	190
Bis (2-Ethylhexyl) Phthalate	ppb	BDL	BDL	BDL	BDL	BDL
Chrysene	ppb	3,400	350	1,300	85,000	210
Benzo (B) Fluoranthene	ppb	44,000	380	1,400	130,000	280
Benzo (K) Fluoranthene	ppb	44,000	380	1,400	130,000	280
Benzo (A) Pyrene	ppb	24,000	220	710	69,000	190
Indeno (1,2,3-c,d) Pyrene	ppb	9,500	BDL	340	30,600	BDL
Dibenzo, (A,H) Anthracene	ppb	3,900	BDL	BDL	BDL	BDL
Benzo (G,H,I) Perylene	ppb	8,400	BDL	350	32,600	BDL
Total Base/Neutrals		568,100	4,880	21,280	2,229,200	2,420
Volatile Organics						
Methylene Chloride	ppb	11	BDL	BDL	BDL	BDL
Benzene	ppb	BDL	BDL	BDL	BDL	9
Toluene	ppb	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	ppb	BDL	BDL	BDL	BDL	BDL
Total Volatiles		11	BDL	BDL	BDL	9

BDL - Below Detection Limit

TABLE 5-5

SOIL QUALITY RESULTS
PRIORITY POLLUTANT ORGANICS DETECTED
PHILADELPHIA, COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Parameter	Units	B-7A	B-7B	B-8A	B-9A	B-9B
Acid Extractables						
Phenol	ppb	1100	330	BDL	BDL	570
2,4-Dimethylphenol	ppb	320	BDL	BDL	BDL	BDL
Total Acids		1420	330	BDL	BDL	570
Base/Neutral Extractables						
Naphthalene	ppb	6,300	1,000	11,000	46,000	46,000
Acenaphthylene	ppb	BDL	BDL	780	4,800	260
Acenapthene	ppb	320	BDL	6,100	250	BDL
Fluorene	ppb	BDL	BDL	4,600	2,200	240
Phenanthrene	ppb	360	BDL	10,000	7,500	970
Anthracene	ppb	370	BDL	3,200	2,300	1,200
Fluoranthene	ppb	1,000	290	6,800	8,300	650
Pyrene	ppb	900	280	4,400	4,400	590
Benzo (A) Anathracene	ppb	1,000	BDL	2,200	3,700	360
Bis (2-Ethylhexyl) Phthalate	ppb	BDL	BDL	BDL	BDL	190
Chrysene	ppb	880	BDL	2,100	3,500	340
Benzo (B) Fluoranthene	ppb	1,700	230	2,100	6,400	430
Benzo (K) Fluoranthene	ppb	1,700	230	2,100	6,400	430
Benzo (A) Pyrene	ppb	980	BDL	1,300	3,500	290
Indeno (1,2,3-c,d)Pyrene	ppb	490	BDL	260	1,800	BDL
Dibenzo (A,H) Anthracene	ppb	BDL	BDL	BDL	190	BDL
Benzo (G,H,I) Perylene	ppb	530	BDL	250	1,700	BDL
Total Base/Neutrals		16,530	2,030	57,190	102,940	51,950
Volatile Organics						
Methylene Chloride	ppb	BDL	BDL	BDL	BDL	BDL
Benzene	ppb	9	15	BDL	BDL	10
Toluene	ppb	BDL	BDL	BDL	BDL	5
Ethylbenzene	ppb	BDL	BDL	BDL	BDL	BDL
Total Volatiles		9	15	BDL	BDL	15

BDL - Below Detection Limit

TABLE 5-5

SOIL QUALITY RESULTS
PRIORITY POLLUTANT ORGANICS DETECTED
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Parameter	Units	Field Blank1	Field Blank	TP-1	TP-2	TP-3	BG1
Acid Extractables							
Phenol	ppb	BDL	BDL	BDL	BDL	BDL	BDL
2,4-Dimethylphenol	ppb	BDL	BDL	BDL	BDL	BDL	BDL
Total Acids		BDL	BDL	BDL	BDL	BDL	BDL
Base/Neutral Extractables							
Naphthalene	ppb	BDL	18	220,000	310	540	BDL
Acenaphthylene	ppb	BDL	BDL	6,500	BDL	220	BDL
Acenapthene	ppb	BDL	BDL	BDL	BDL	BDL	BDL
Fluorene	ppb	BDL	BDL	69,000	BDL	BDL	BDL
Phenanthrene	ppb	BDL	11	230,000	590	1,000	1,300
Anthracene	ppb	BDL	BDL	53,000	200	480	330
Fluoranthene	ppb	BDL	5	130,000	310	1,900	1,400
Pyrene	ppb	BDL	BDL	140,000	360	2,200	1,600
Benzo (A) Anathracene	ppb	BDL	BDL	54,000	220	1,100	610
Bis (2-Ethylhexyl) Phthalate	ppb	10	8	BDL	BDL	BDL	BDL
Chrysene	ppb	BDL	BDL	49,000	450	1,300	710
Benzo (B) Fluoranthene	ppb	BDL	BDL	70,000	780	1,900	1,000
Benzo (K) Fluoranthene	ppb	BDL	BDL	70,000	780	1,900	1,000
Benzo (A) Pyrene	ppb	BDL	BDL	40,000	450	960	570
Indeno (1,2,3-c,d) Pyrene	ppb	BDL	BDL	BDL	290	440	200
Dibenzo, (A,H) Anthracene	ppb	BDL	BDL	BDL	BDL	210	BDL
Benzo (G,H,I) Perylene	ppb	BDL	BDL	BDL	310	460	230
Total Base/Neutrals		10	42	1,131,500	5,050	14,610	8,950
Volatile Organics							
Methylene Chloride	ppb	BDL	BDL	10	17	BDL	BDL
Benzene	ppb	BDL	BDL	BDL	BDL	6	BDL
Toluene	ppb	BDL	BDL	22	BDL	BDL	BDL
Ethylbenzene	ppb	13	BDL	BDL	BDL	BDL	BDL
Total Volatiles		13	BDL	32	17	6	BDL

BDL - Below Detection Limit

TABLE 5-6

EPA DRINKING WATER STANDARDS
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Parameter	Interim Primary Standard (ppm)	Interim Secondary Standard (ppm)
Arsenic	0.050	
Barium	1	
Cadmium	0.01	
Chloride		250
Chromium	0.05	
Copper		1
Fluoride	1.4-2.4	
Iron		0.3
Lead	0.05	
Manganese		0.05
Mercury	0.002	
Nitrate (as Nitrogen)	10	
pH		6.5-8.5 units
Selenium	0.01	
Silver	0.05	
Sodium	no standard	
Sulfate		250
Total Cyanides	0.2	
Total Dissolved Solids		500
Zinc		5

Source: 40 CFR Part 143 and 265, Appendix III, 7/1/85 Edition.

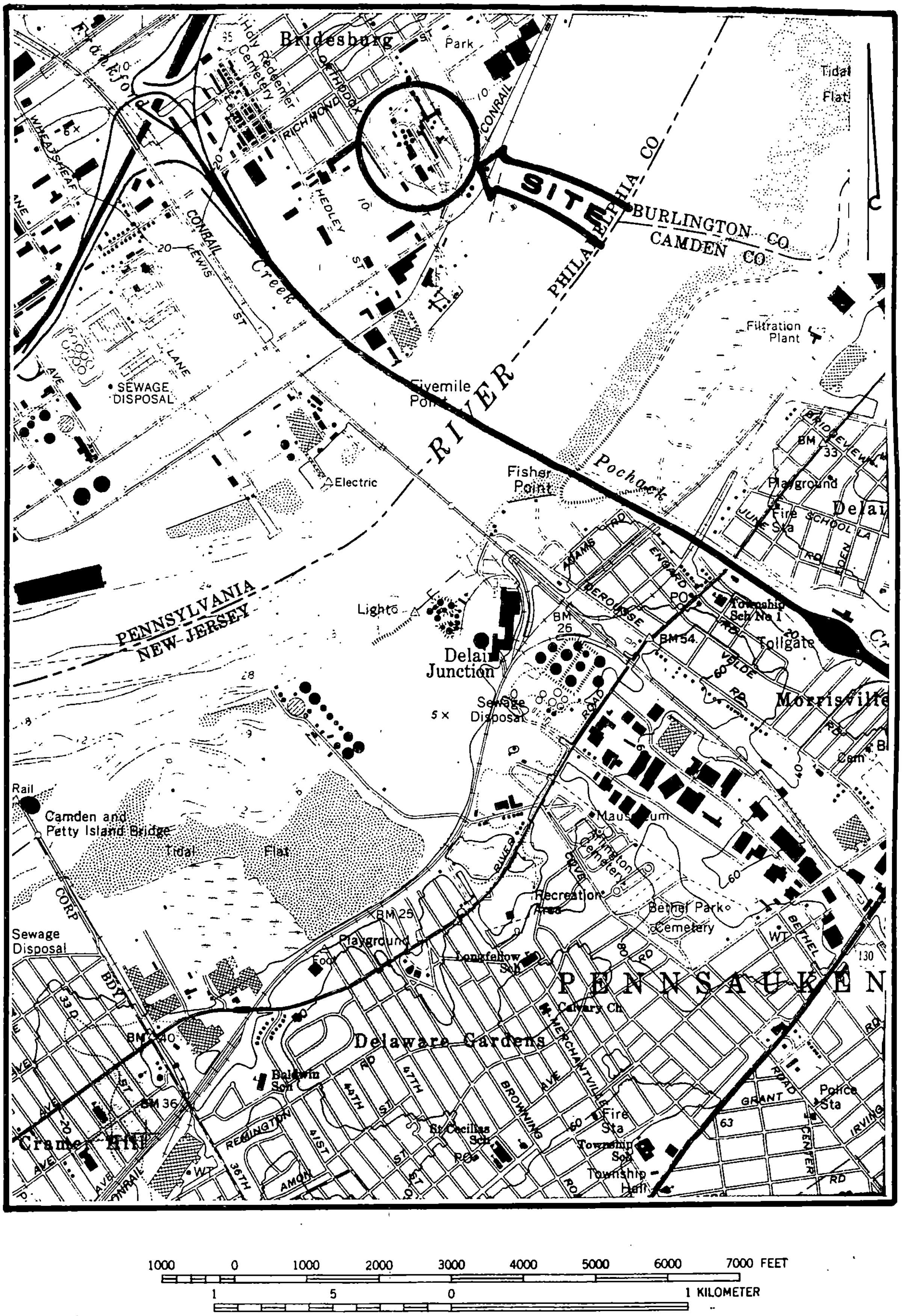
TABLE 5-7

PRIORITY POLLUTANT WATER QUALITY CRITERIA
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

Parameter	Acceptable Concentration (ppb)	Guideline Basis
Acid Extractables		
Phenol	3500	Ambient Water Quality Criteria
2,4-Dimethylphenol	400	Organoleptic Ambient Water Criteria
Base/Neutral Extractables		
Naphthalene	No standard	
Acenapthylene	2.8×10^{-2}*	
Acenapthene	2.8×10^{-2}*	Ambient Water Quality Criteria
Fluorene	2.8×10^{-2}*	Ambient Water Quality Criteria
Phenanthrene	2.8×10^{-2}*	Ambient Water Quality Criteria
Benzo(a)pyrene	2.8×10^{-2}*	Ambient Water Quality Criteria
Benzo(a)anthracene	2.8×10^{-2}*	Ambient Water Quality Criteria
Pyrene	2.8×10^{-2}*	Ambient Water Quality Criteria
Fluoranthene	42	Ambient Water Quality Criteria
Bis (2-Chloroethyl)ether	0.3*	Ambient Water Quality Criteria
Hexachloroethane	19*	Ambient Water Quality Criteria
Nitrobenzene	19,800	Ambient Water Quality Criteria
2-6, Dinitrotoluene	No standard	
Bis (2-Chloroethoxy)methane	No standard	
Bis (2-Ethylhexyl)phthalate	4200	Suggested No Adverse Response Level
Volatile Organics		
Methylene Chloride	50*	Ambient Water Quality Criteria
Benzene	5	Maximum Contaminant Level
Toluene	2000	Recommended Maximum Contaminant Level
Ethylbenzene	680	Recommended Maximum Contaminant Level

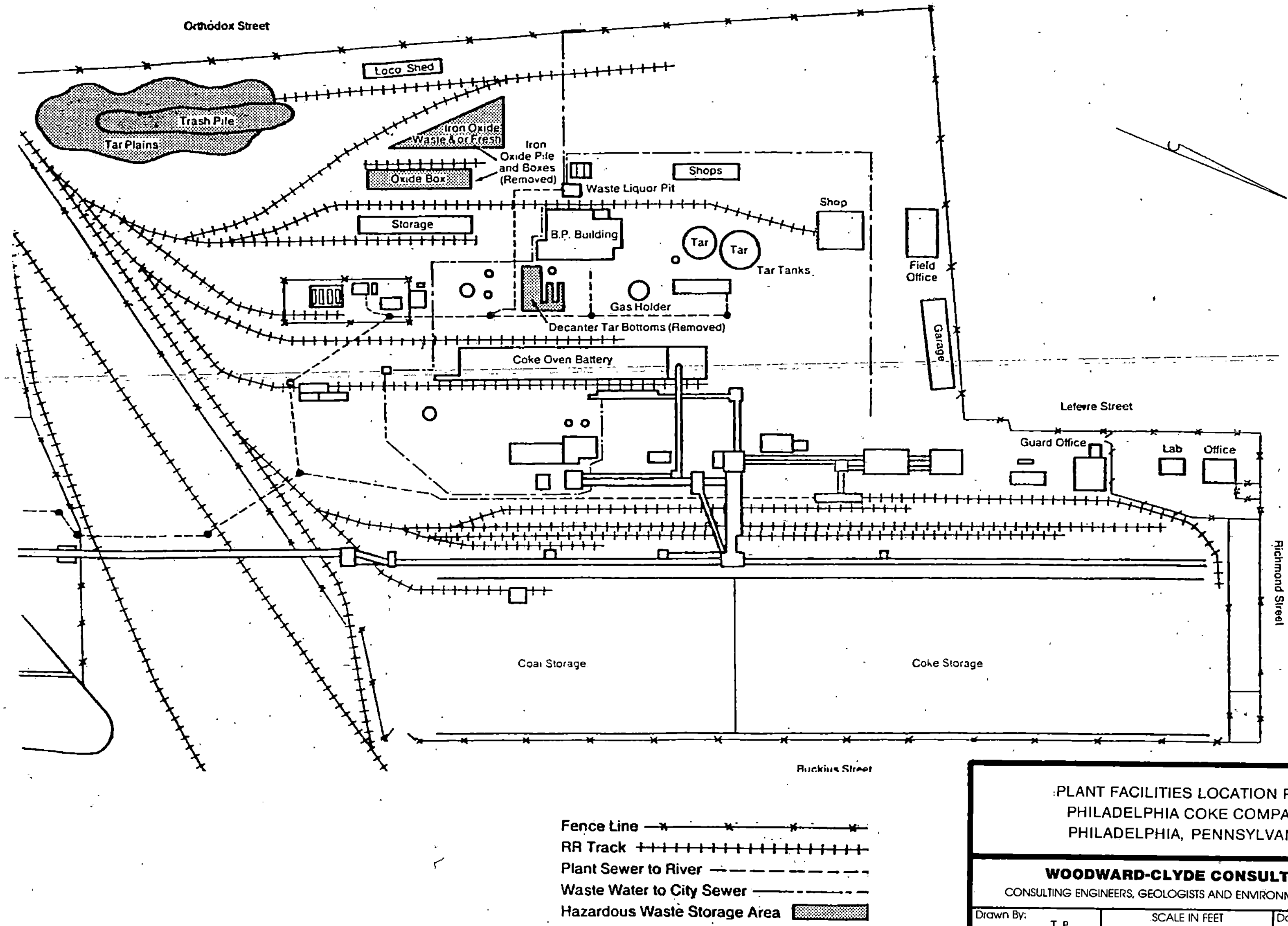
* For an incremental increased lifetime cancer risk of 10^{-5}.

Figures



REGIONAL LOCATION PLAN

FIGURE 1-1

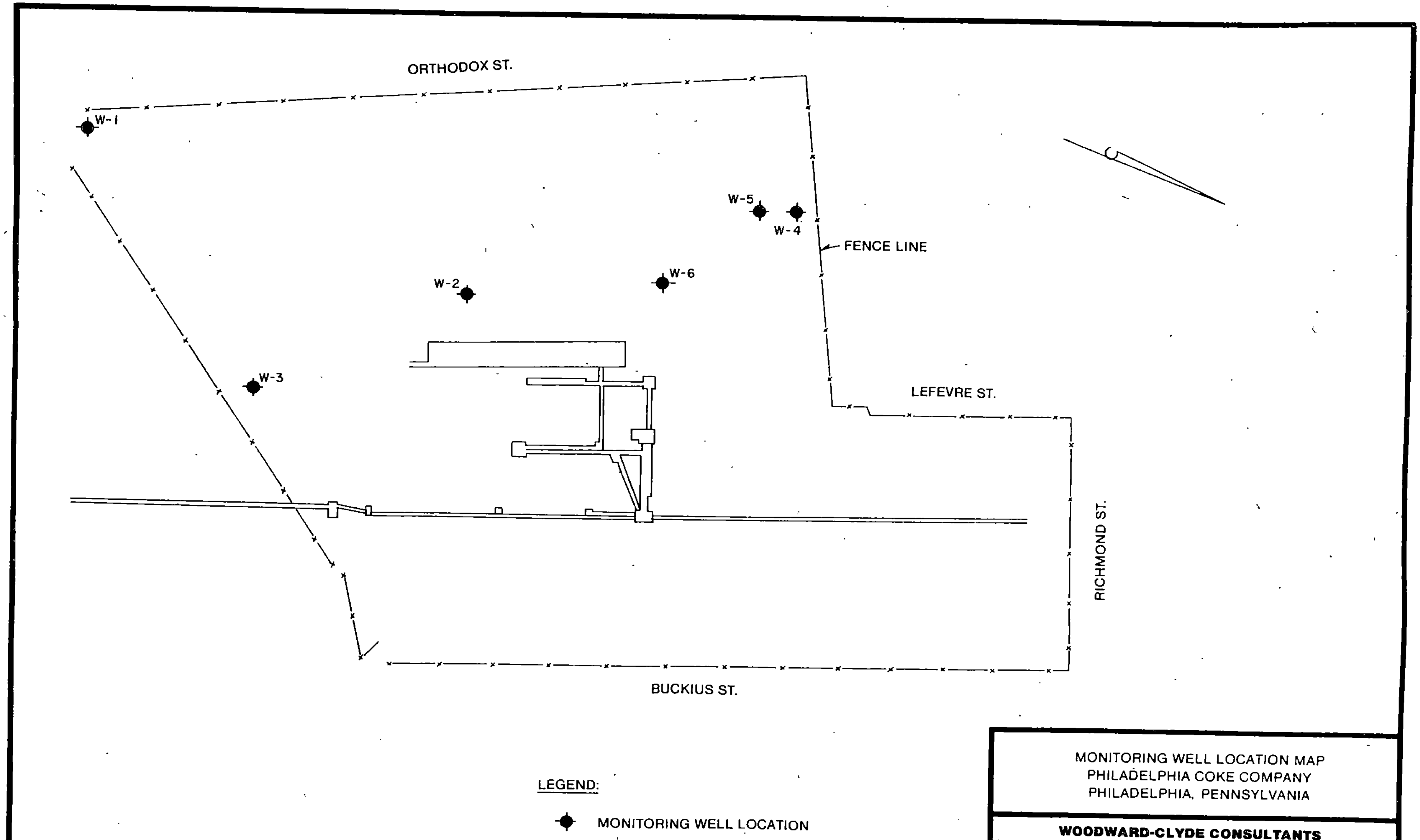


PLANT FACILITIES LOCATION PLAN
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn By: T.P.	SCALE IN FEET	Date: 12/5/86
Checked: A.W.L.	0 100 200	Job: 84C2145

FIGURE 1-2

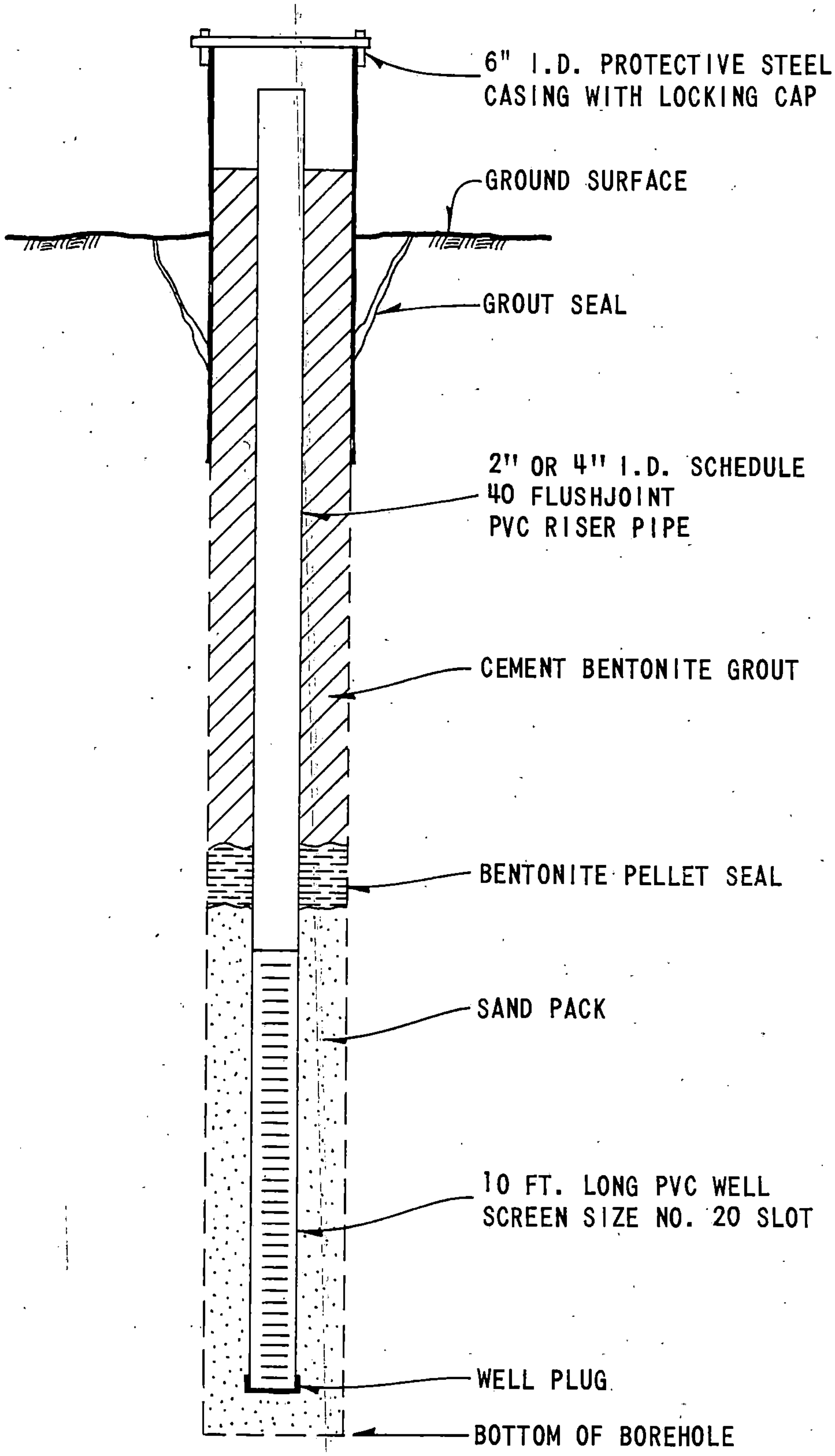


MONITORING WELL LOCATION MAP
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: T.P.	SCALE IN FEET	Date: 12/4/86
Checked by: A.W.L.	0 200	Job: 84C2145

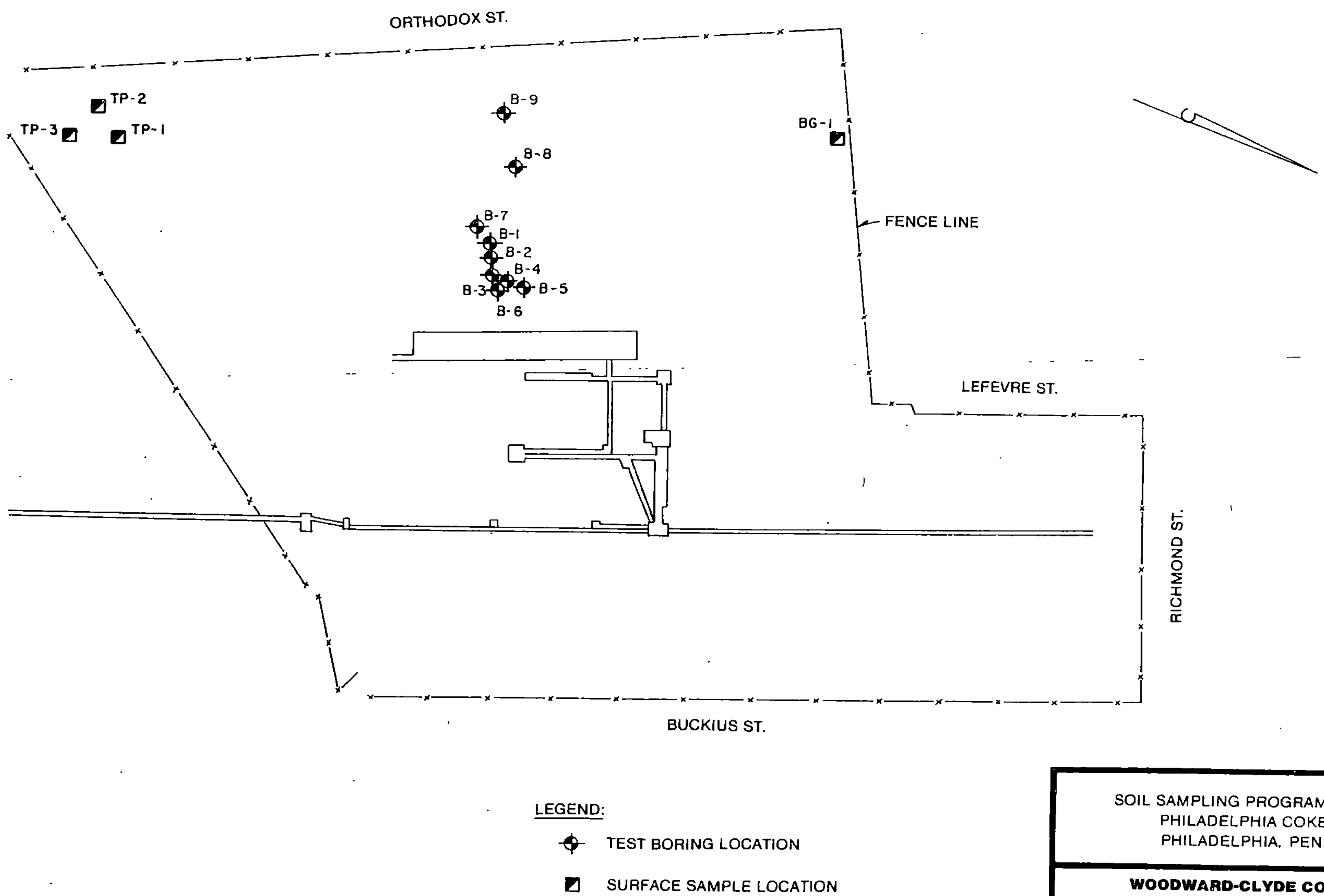
FIGURE 2-1



NOTE: SEE APPENDIX B FOR SPECIFIC WELL CONSTRUCTION DETAILS

TYPICAL MONITORING WELL CONSTRUCTION
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

FIGURE 2-2

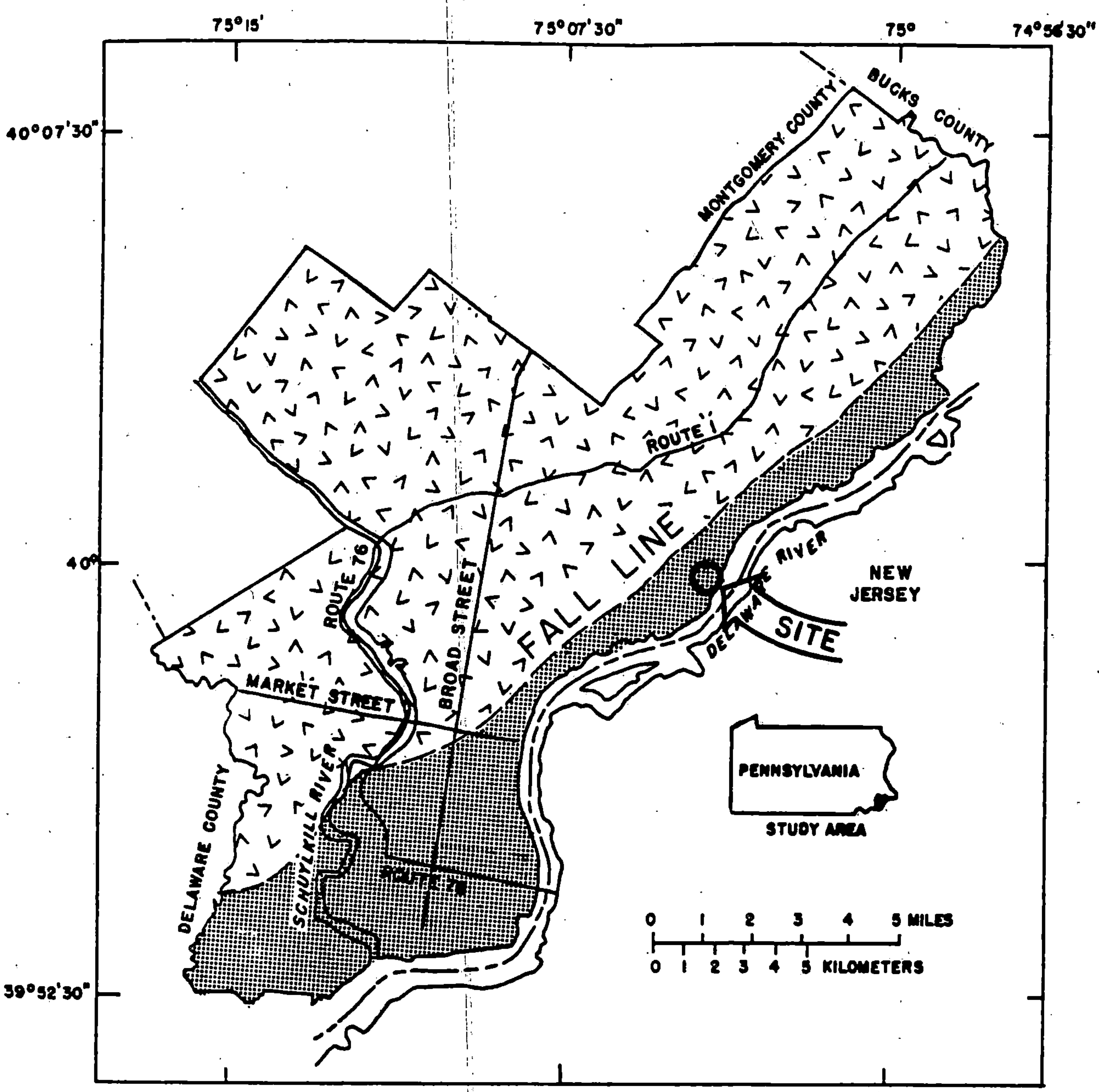


SOIL SAMPLING PROGRAM, OCTOBER 1986
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: T.P.	SCALE IN FEET 0 200	Date: 12/4/86
Checked by: A.W.L.		Job: 84C2145

FIGURE 2-3



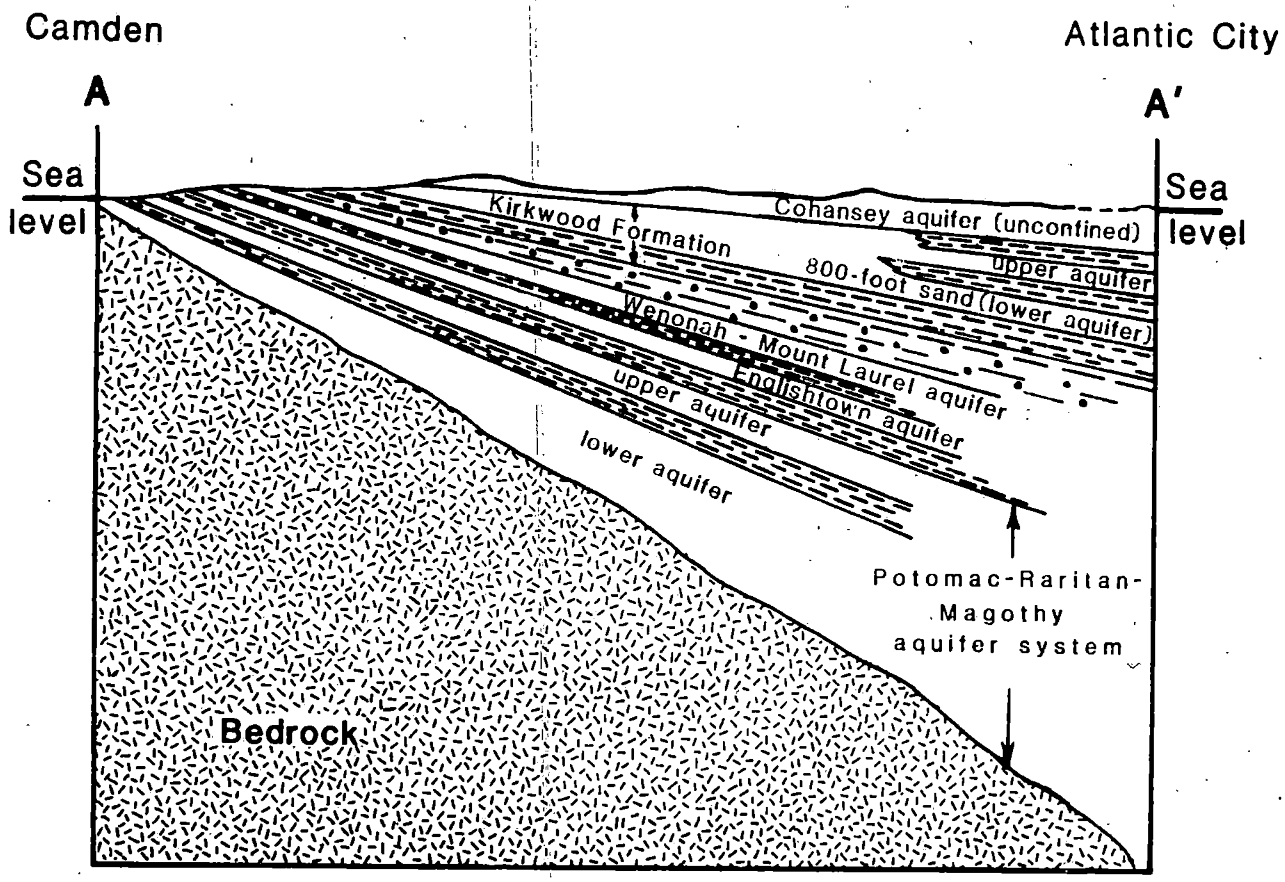
EXPLANATION

PIEDMONT
Underlain by crystalline rocks, chiefly schist of the Wissahickon Formation, lesser amounts of quartzite of the Chickies Formation, and gneissose rocks of granitic to gabbroic composition

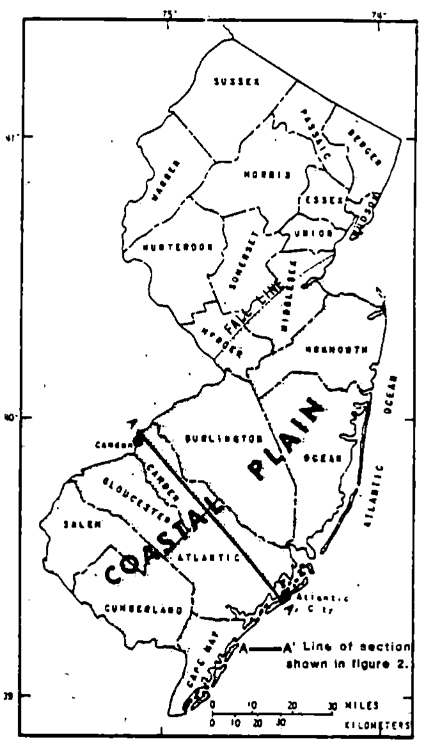
COASTAL PLAIN
Underlain by unconsolidated deposits of gravel, sand, silt, and clay. Includes Potomac-Raritan-Magothy aquifer system.

GENERALIZED GEOLOGY, PHILADELPHIA COUNTY
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

FIGURE 3-1



Not to scale



EXPLANATION

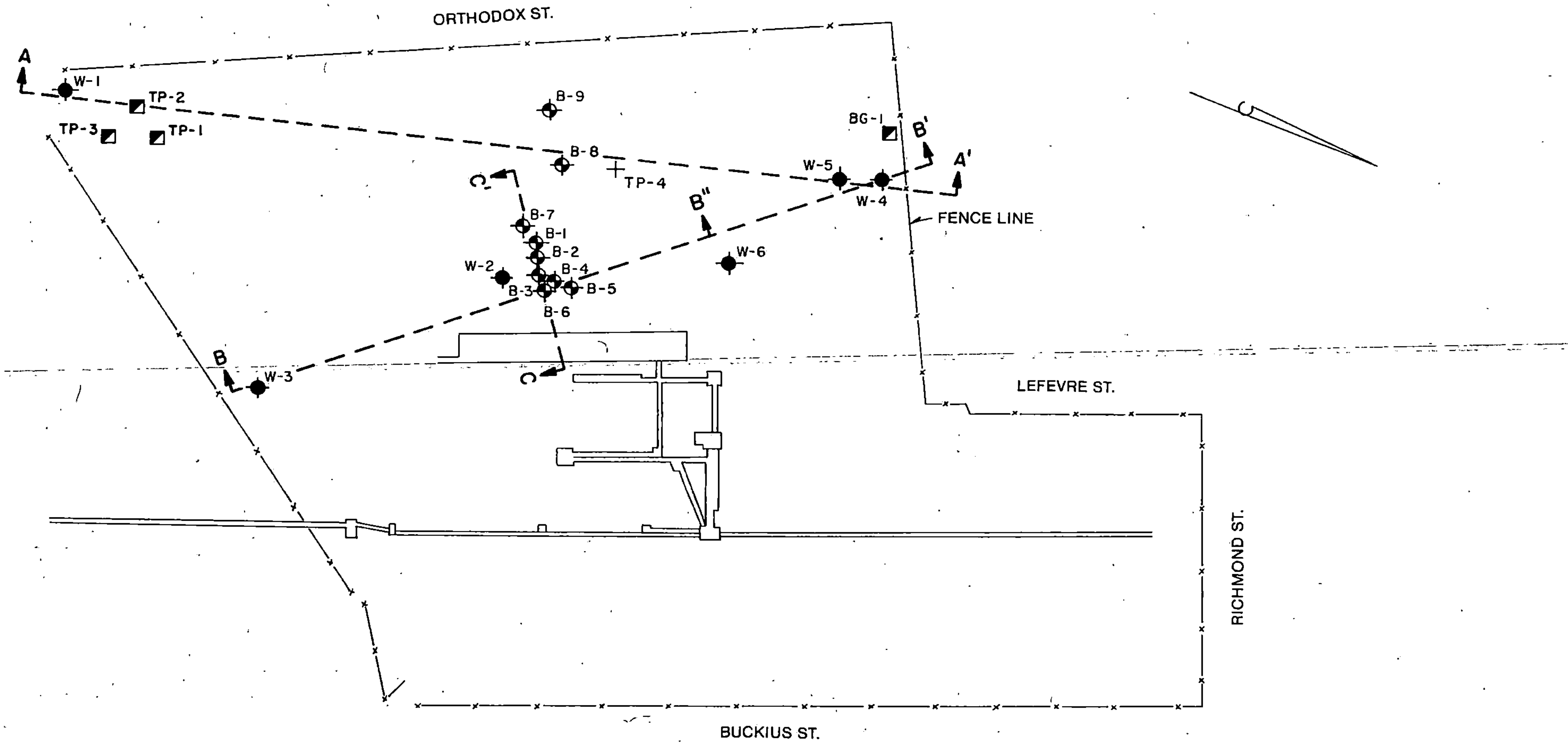
Composite confining layer and minor aquifer

Confining layer

(From U.S. Geological Survey Open File Report 82-4077, 1983)

GENERALIZED GEOLOGIC CROSS-SECTION
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

FIGURE 3-2



LEGEND:

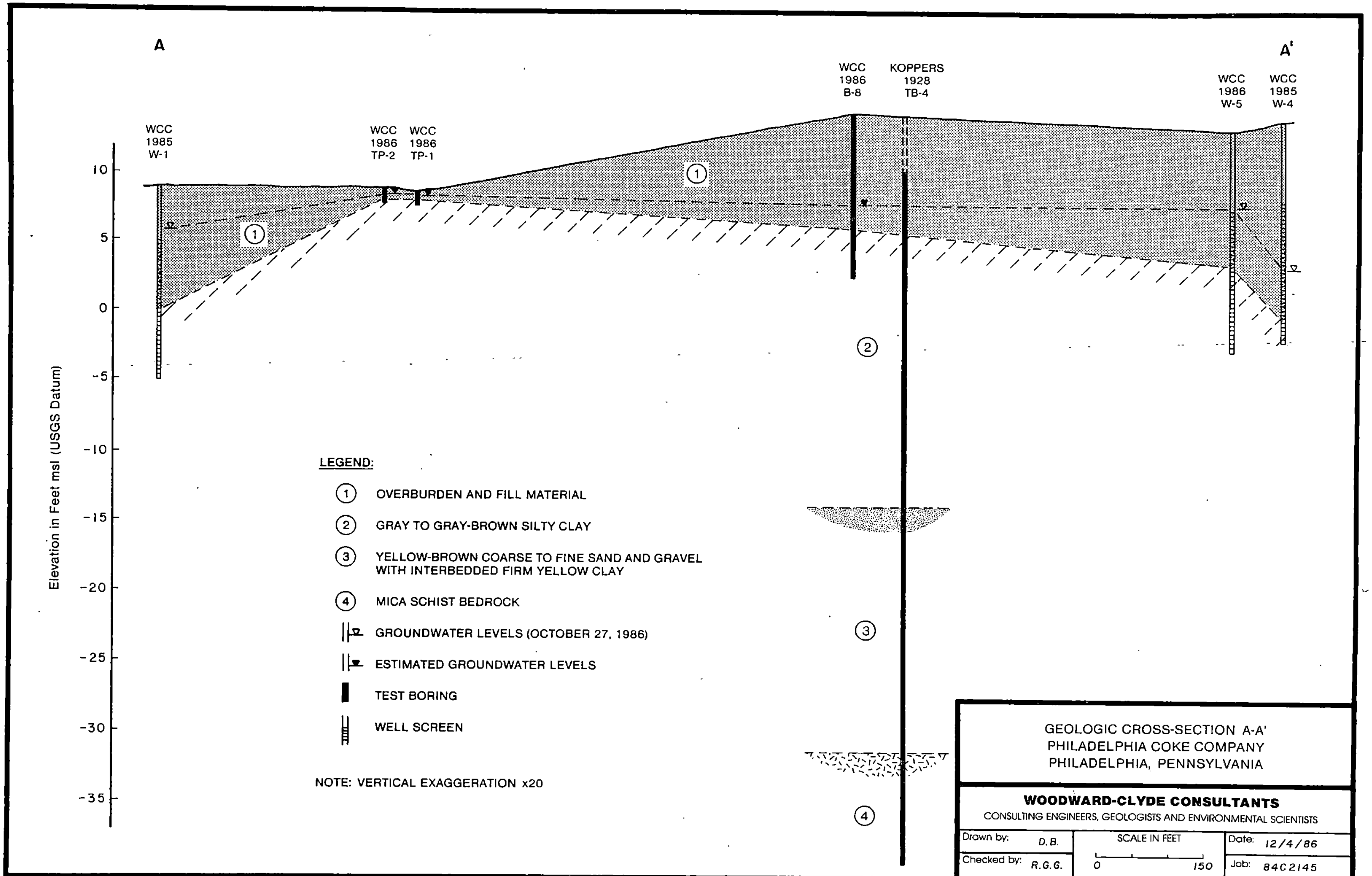
- TEST BORING LOCATION
- MONITORING WELL LOCATION
- SURFACE SAMPLE LOCATION
- HISTORIC TEST BORING

CROSS-SECTION LOCATION PLAN
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: T.P.	SCALE IN FEET 0 200	Date: 12/4/86
Checked by: A.W.L.		Job: 84C2145

FIGURE 3-3

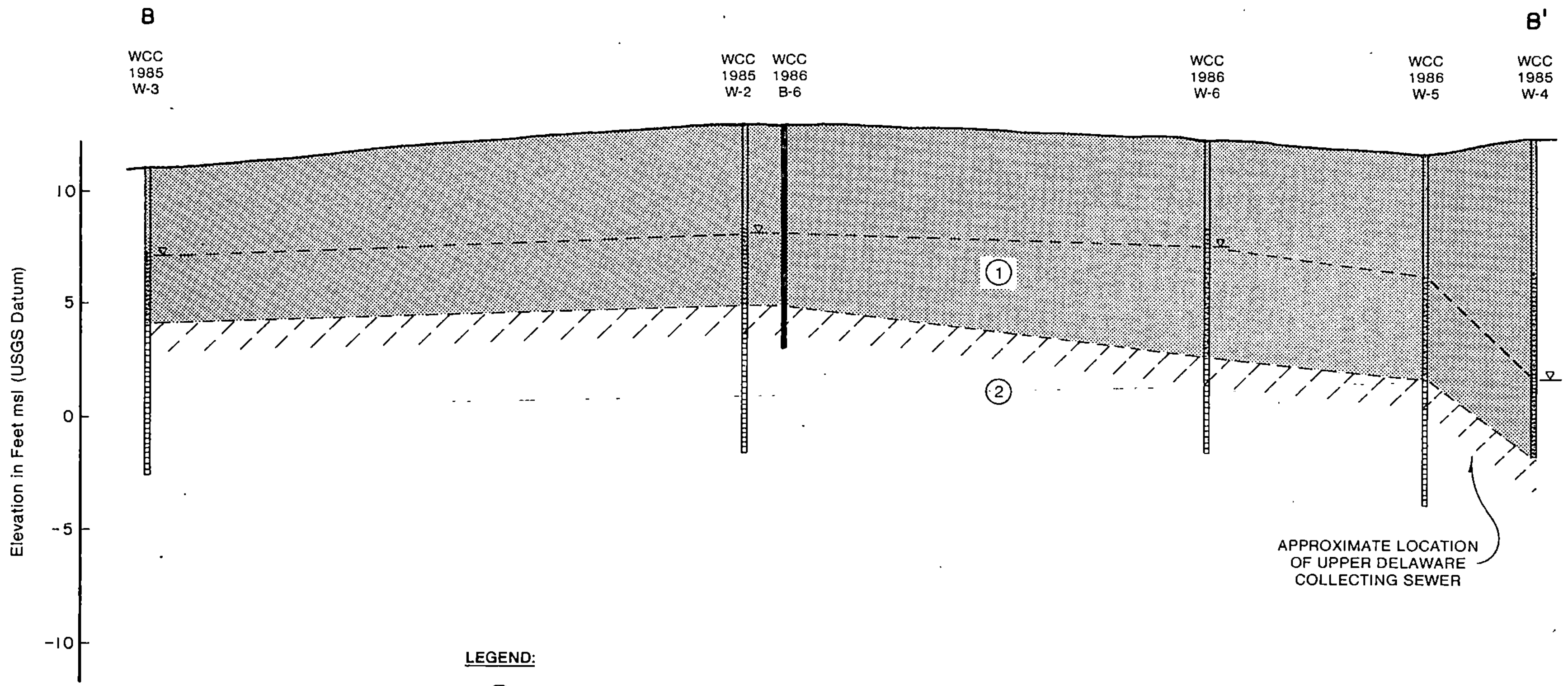


GEOLOGIC CROSS-SECTION A-A'
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: D. B.	SCALE IN FEET	Date: 12/4/86	
Checked by: R. G. G.	0 — 150	Job: 84C2145	

FIGURE 3-4



LEGEND:

1. OVERBURDEN AND FILL MATERIAL
2. GRAY TO GRAY-BROWN SILTY CLAY

GROUNDWATER LEVELS (OCTOBER 27, 1986)

TEST BORING

WELL SCREEN

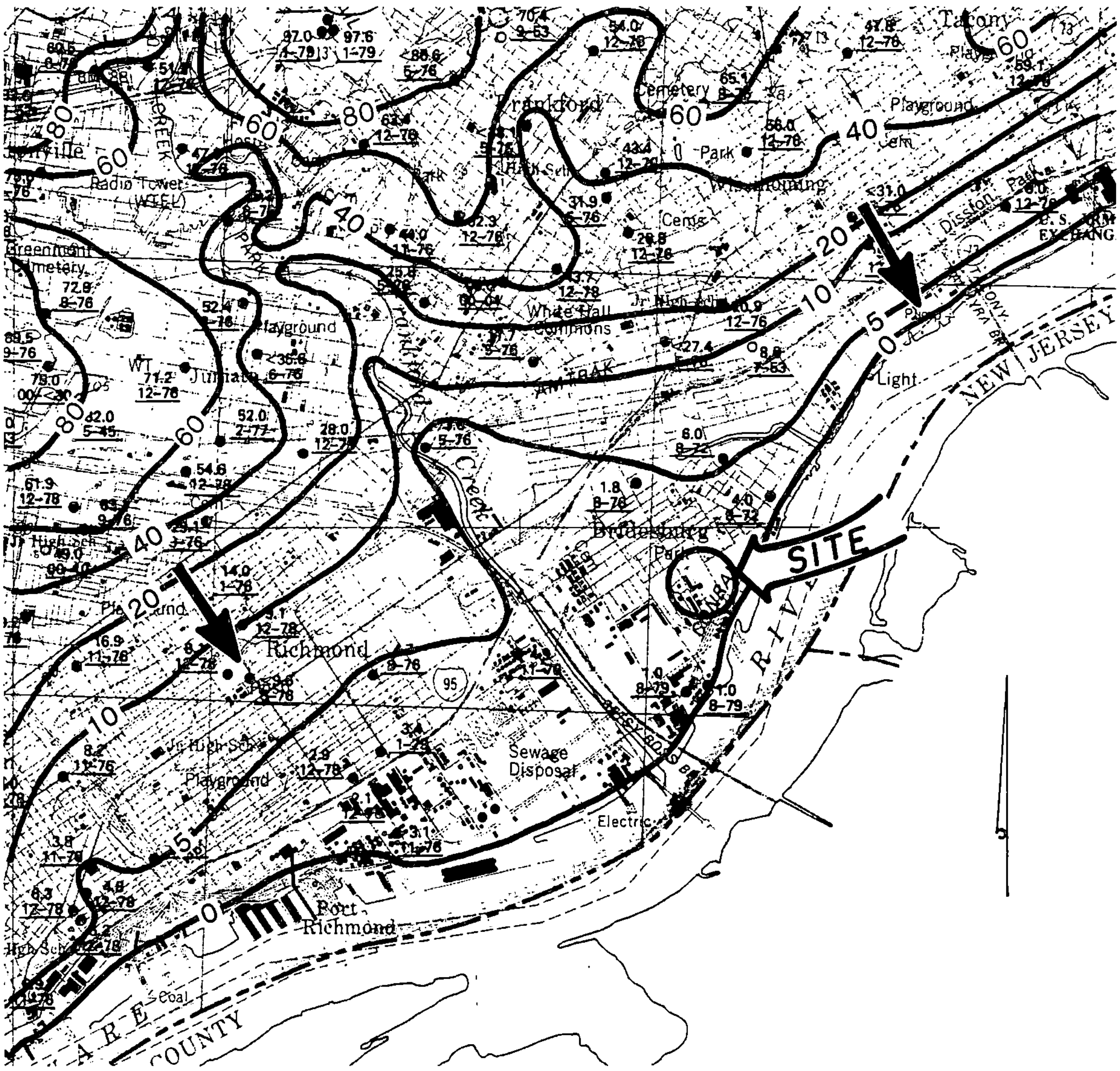
NOTE: VERTICAL EXAGGERATION x20

GEOLOGIC CROSS-SECTION B-B'
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: D. B.	SCALE IN FEET	Date: 12/4/86
Checked by: R.G.G.	0 100	Job: 84C2145

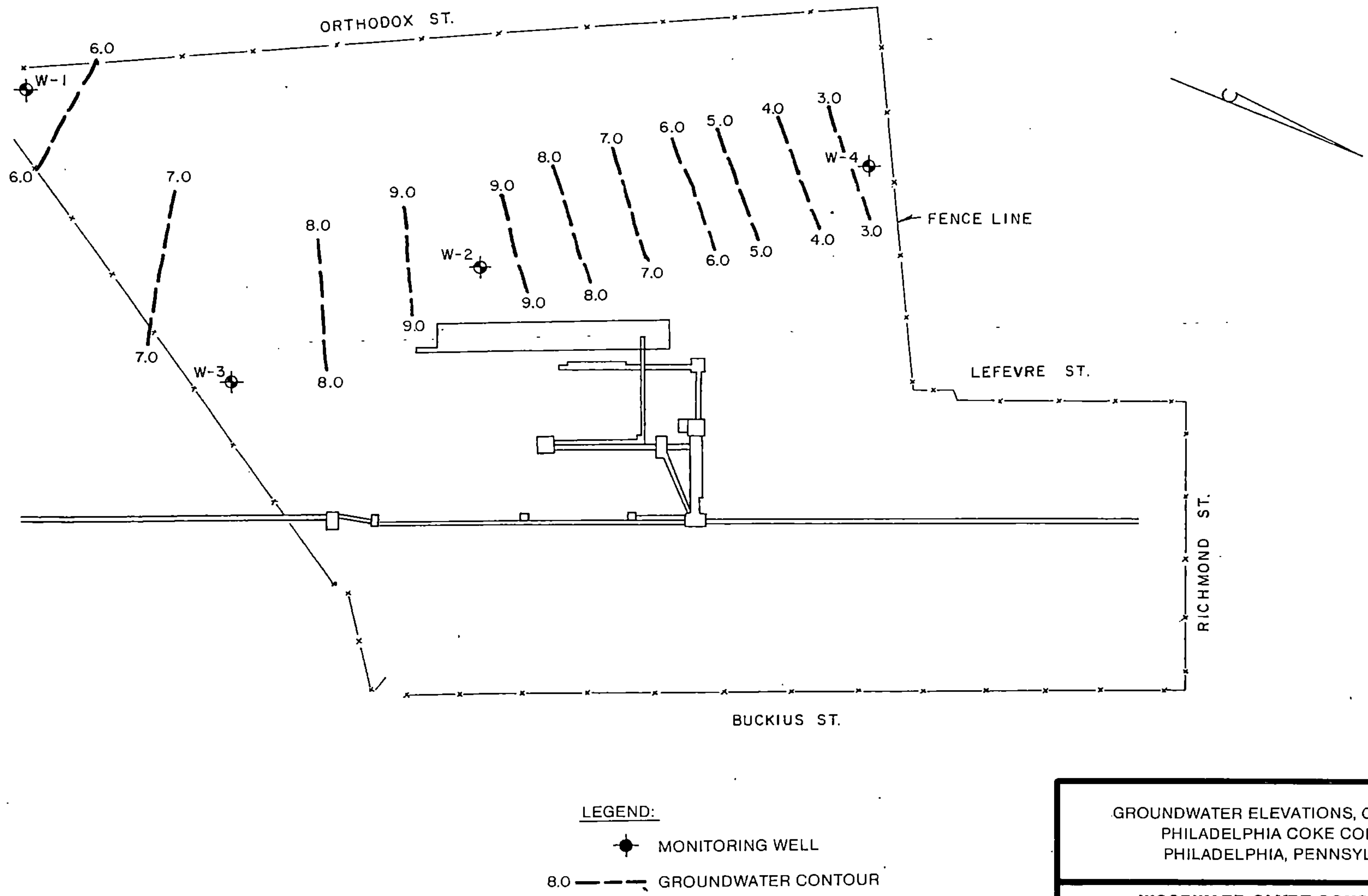
FIGURE 3-5



NOTE: GROUNDWATER ELEVATION CONTOURS ARE SHOWN AS U.S.G.S. DATUM ELEVATIONS.

FROM: PAVACHOK, G.N. AND WOOD, C.R., 1984 WATER TABLE MAP OF PHILADELPHIA, PENNSYLVANIA, 1976-1980.

REGIONAL GROUNDWATER FLOW
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

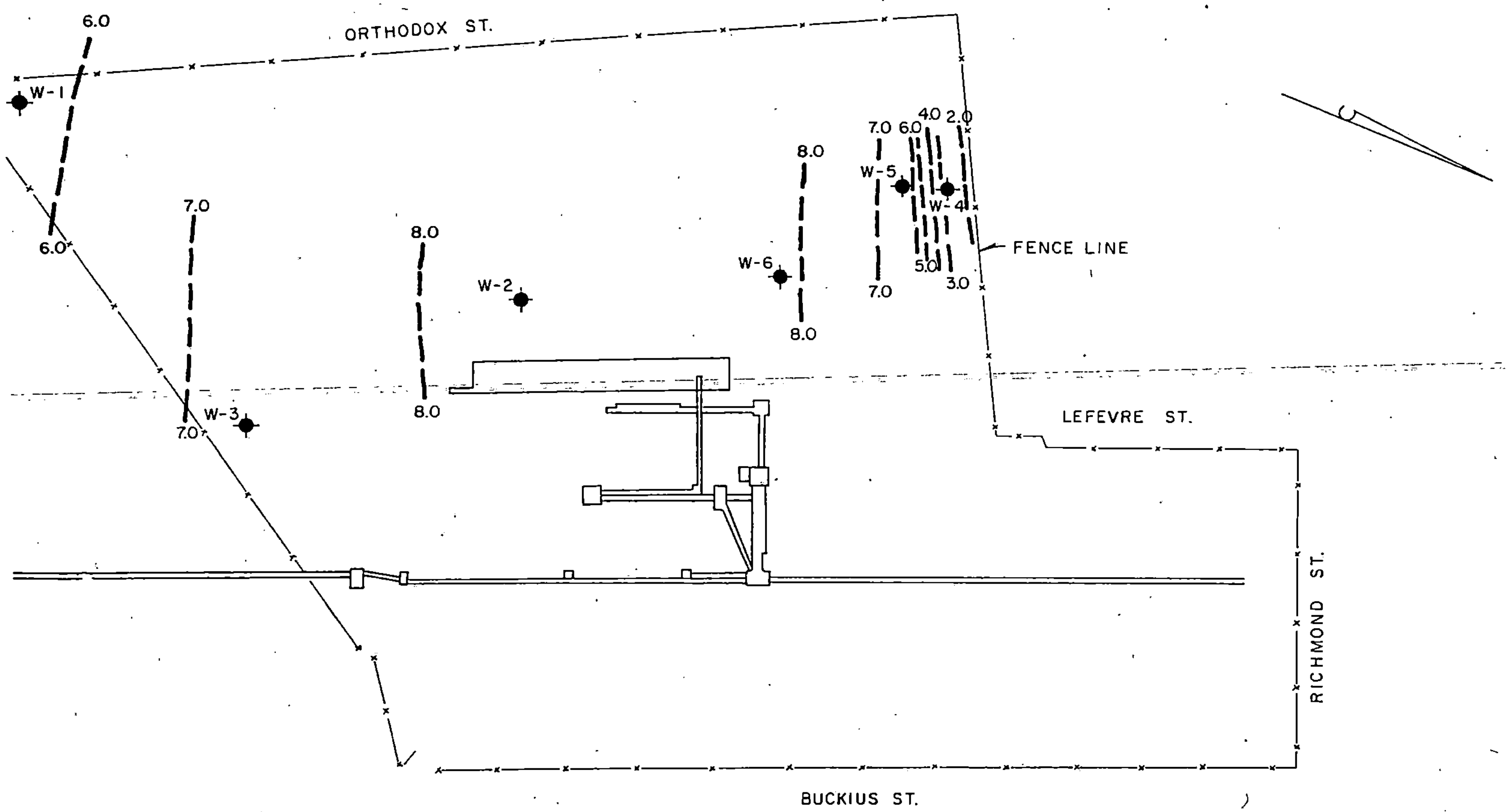


GROUNDWATER ELEVATIONS, OCT. 10, 1986
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn By: T. P.	SCALE IN FEET		Date 12/8/86
Checked: T.W.T.	0 200		Job. 84C2145

FIGURE 4-2



LEGEND:

MONITORING WELL

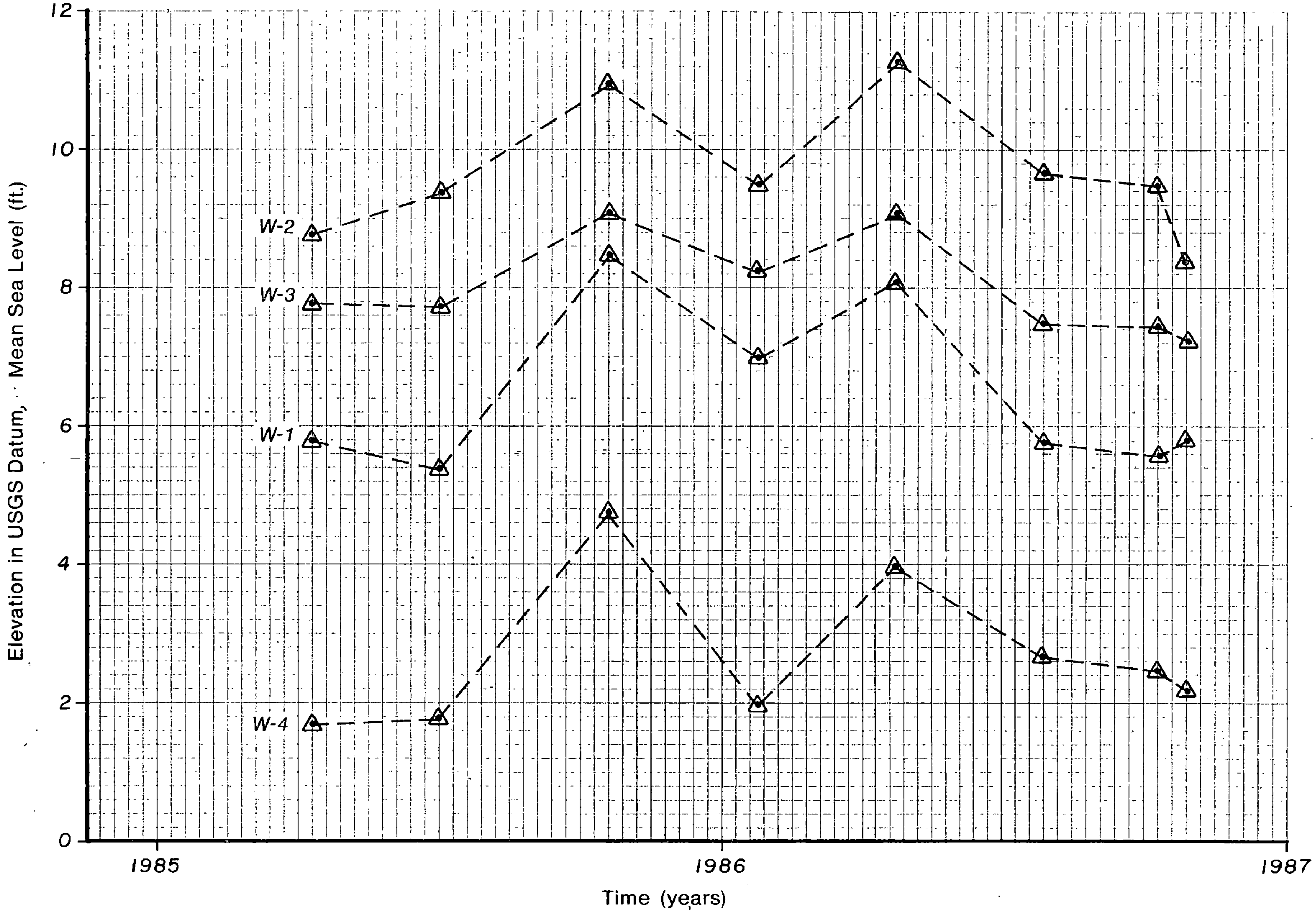
8.0 GROUNDWATER CONTOUR

GROUNDWATER ELEVATIONS, OCT. 27, 1986
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

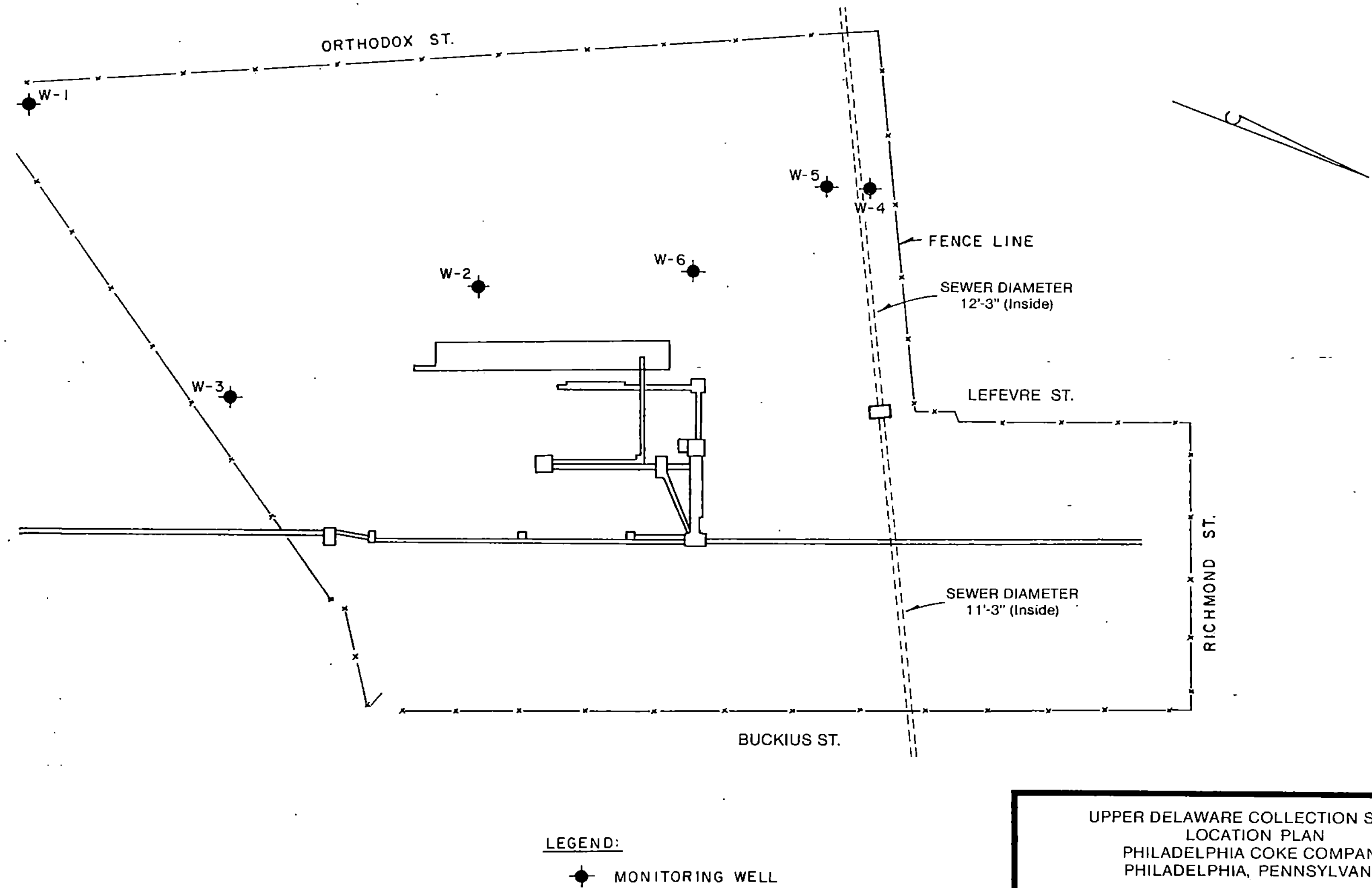
Drawn By: T. P.	SCALE IN FEET 0 200	Date: 12/8/86
Checked: T.W.T.		Job: 84C2145

FIGURE 4-3



SHALLOW GROUNDWATER ELEVATIONS
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

FIGURE 4-4

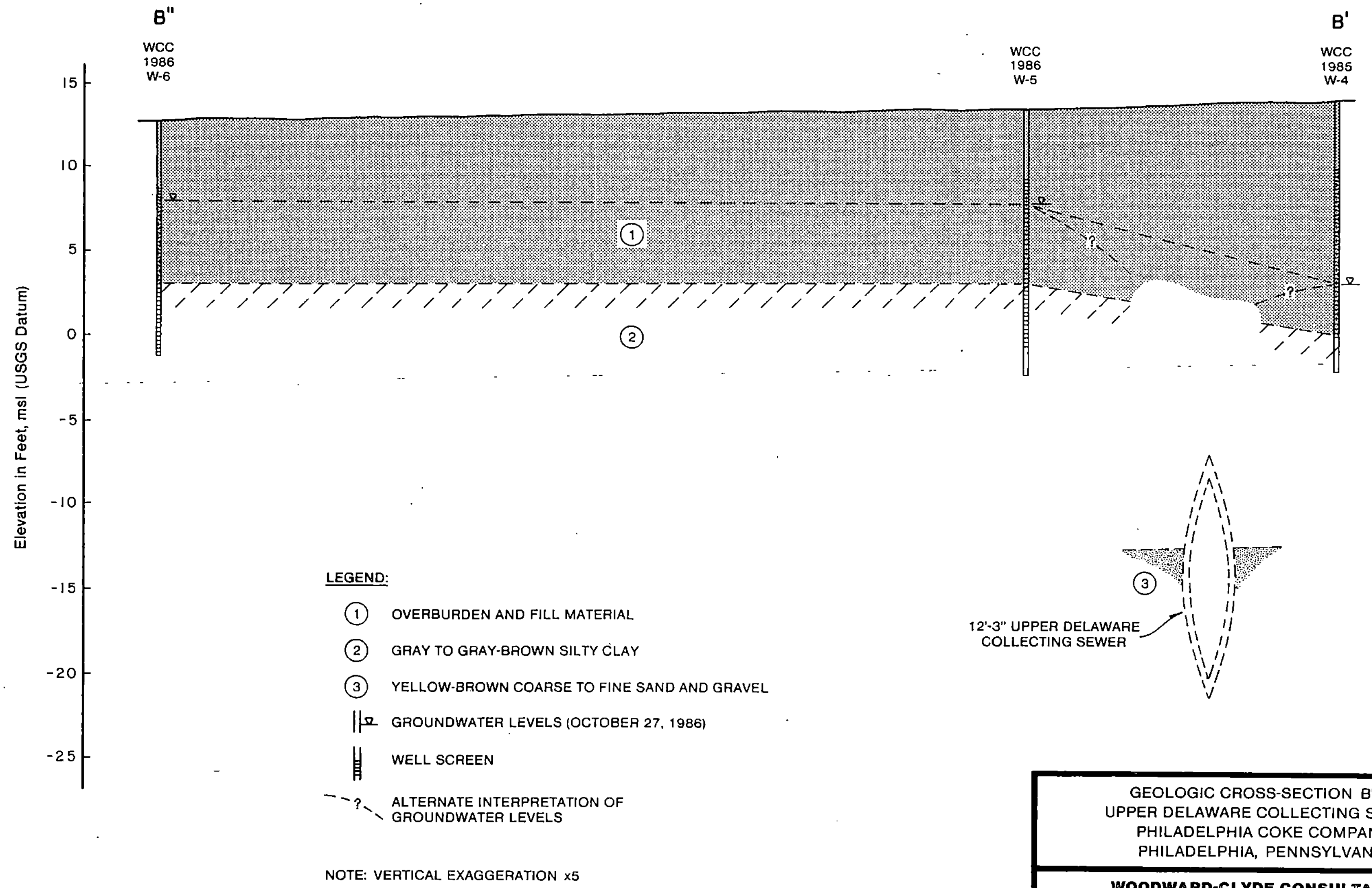


UPPER DELAWARE COLLECTION SEWER
LOCATION PLAN
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: D.B.	SCALE IN FEET	Date: 12/15/86
Checked by: A.W.L.	0 200	Job: 84C2145

FIGURE 4-5

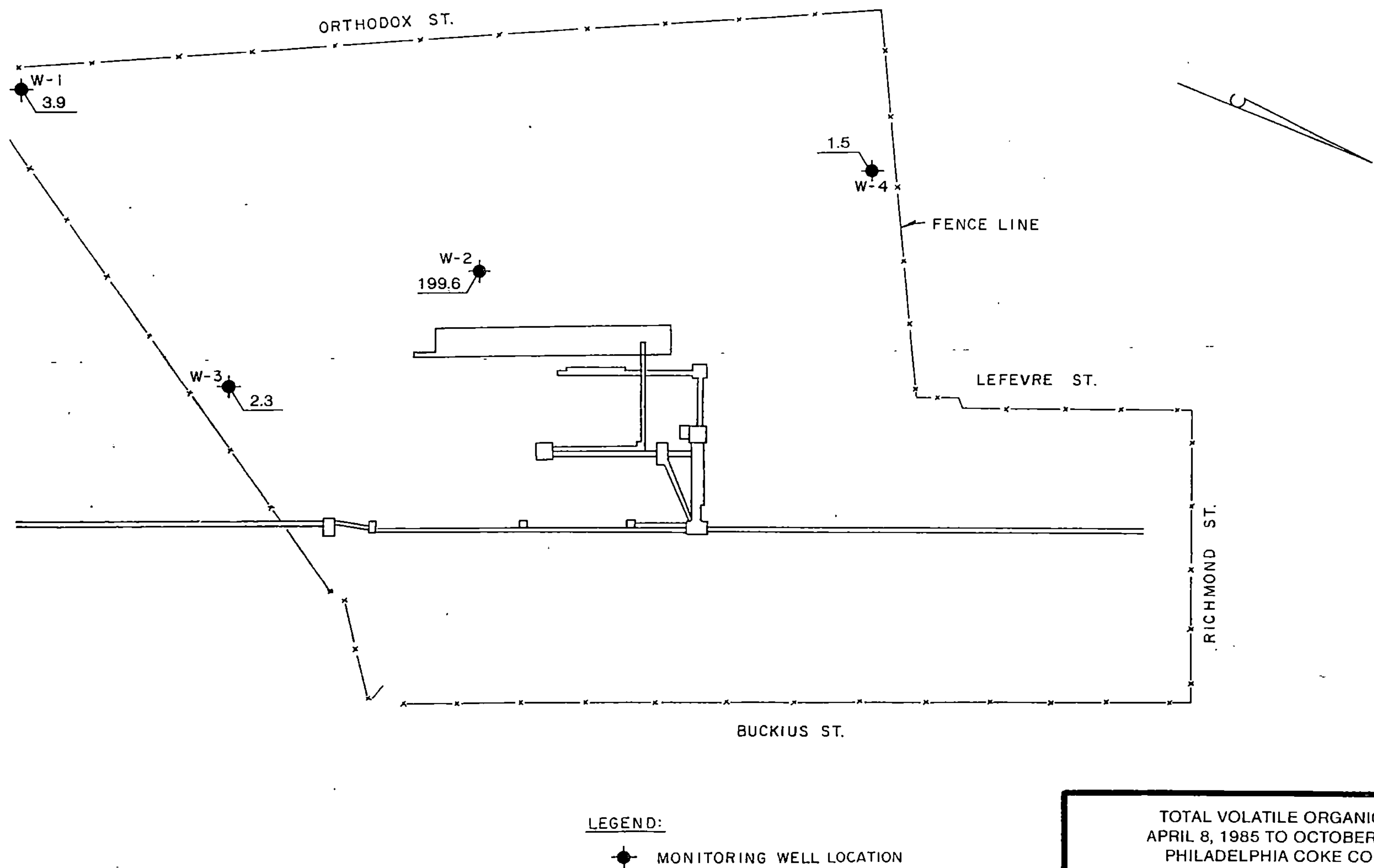


GEOLOGIC CROSS-SECTION B"-B'
UPPER DELAWARE COLLECTING SEWER
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: D.B.	SCALE IN FEET	Date: 12/10/86	
Checked by: R.G.G.	0 30	Job: 84C2145	

FIGURE 4-6

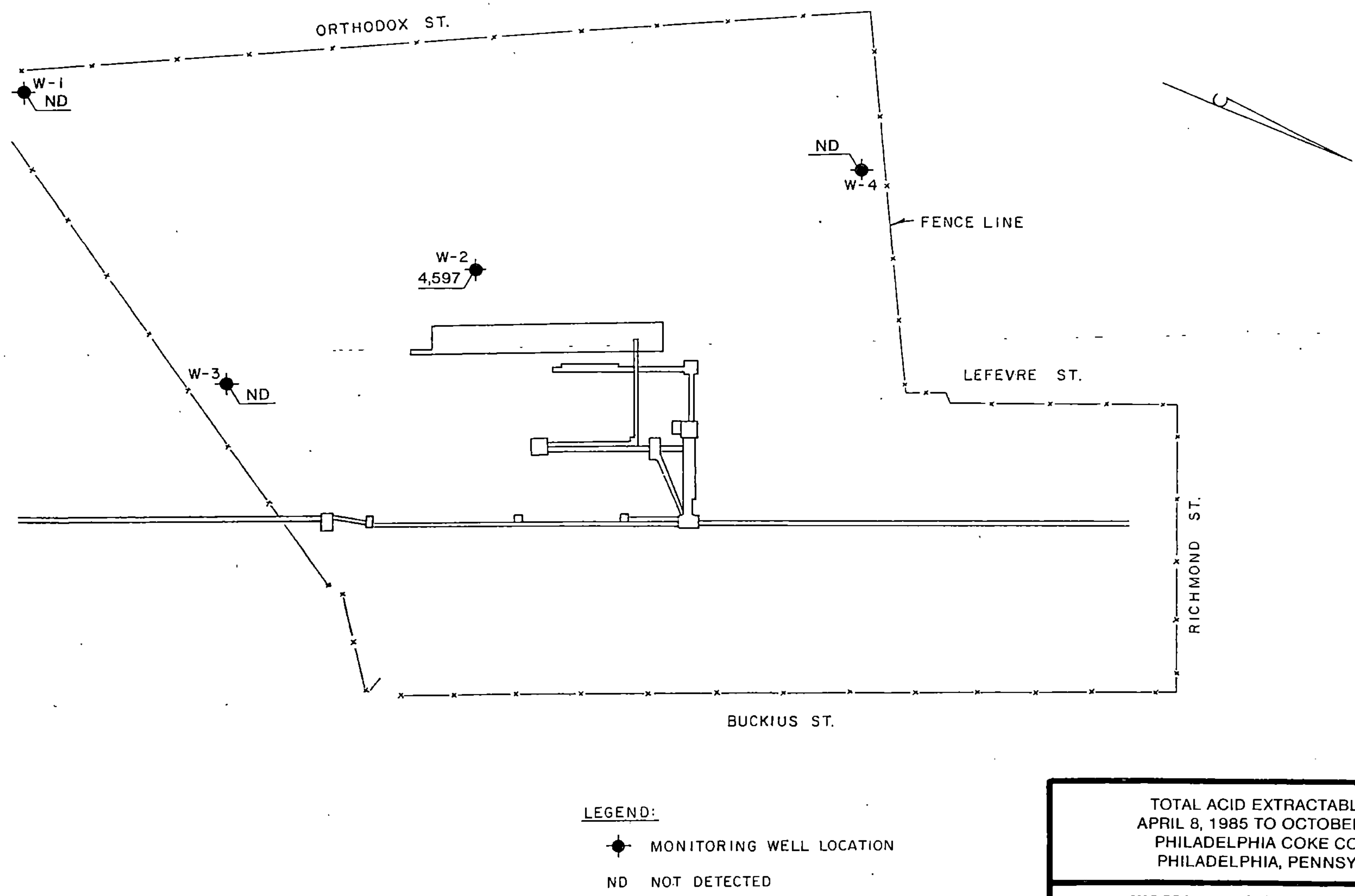


TOTAL VOLATILE ORGANICS (ppb)
APRIL 8, 1985 TO OCTOBER 10, 1986
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn By: T. P.	SCALE IN FEET 0 200	Date: 9/10/86
Checked: T.W.T.		Job: 84C2145

FIGURE 5-1

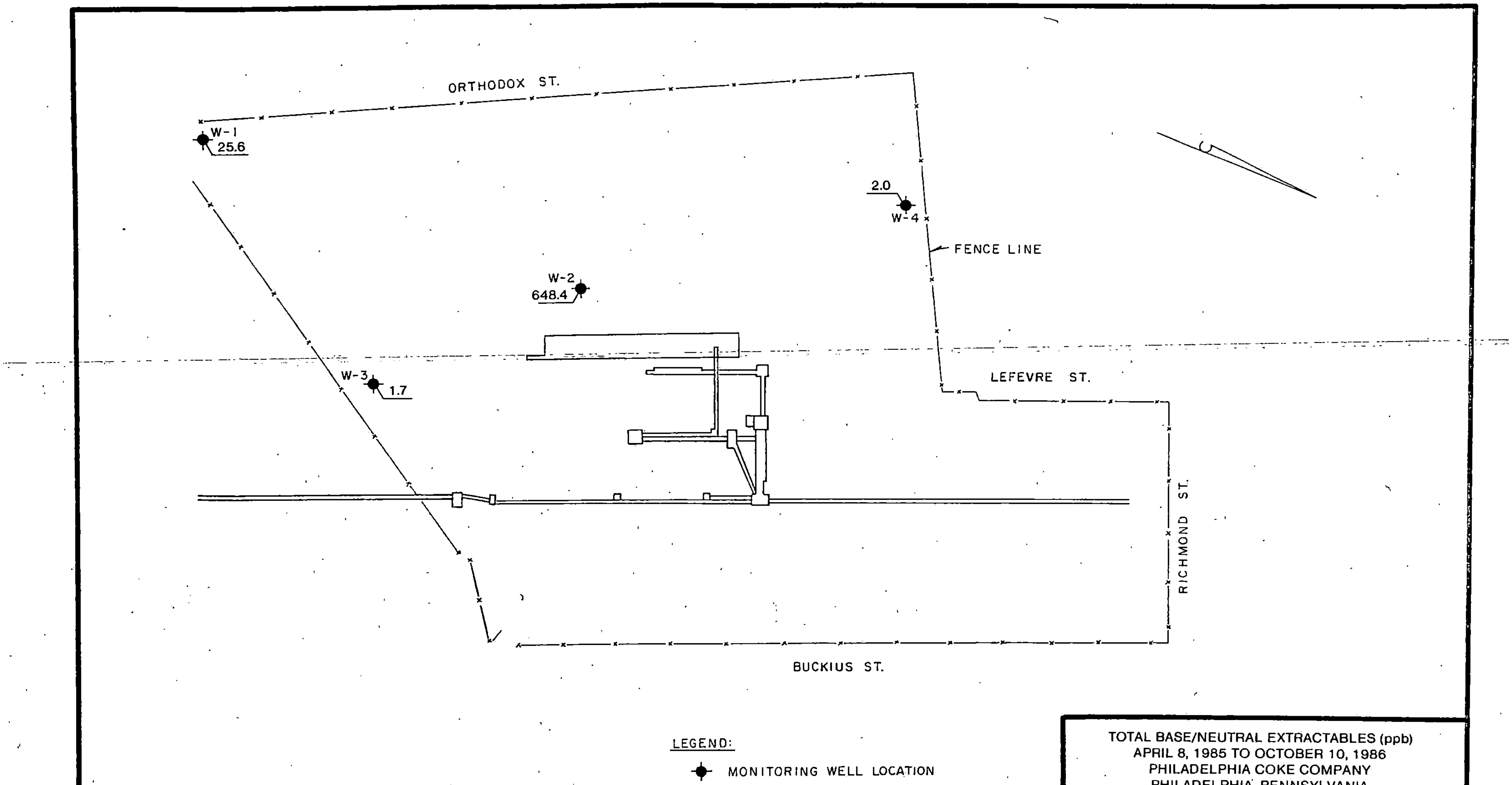


TOTAL ACID EXTRACTABLES (ppb)
APRIL 8, 1985 TO OCTOBER 10, 1986
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn By	T. P.	SCALE IN FEET 0 200	Date	9/10/86
Checked	T.W.T.		Job	84C2145

FIGURE 5-2



TOTAL BASE/NEUTRAL EXTRACTABLES (ppb)
APRIL 8, 1985 TO OCTOBER 10, 1986
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn By. T. P.	SCALE IN FEET	Date	9/10/86
Checked T.W.T.	0 200	Job	84C2145

FIGURE 5-3

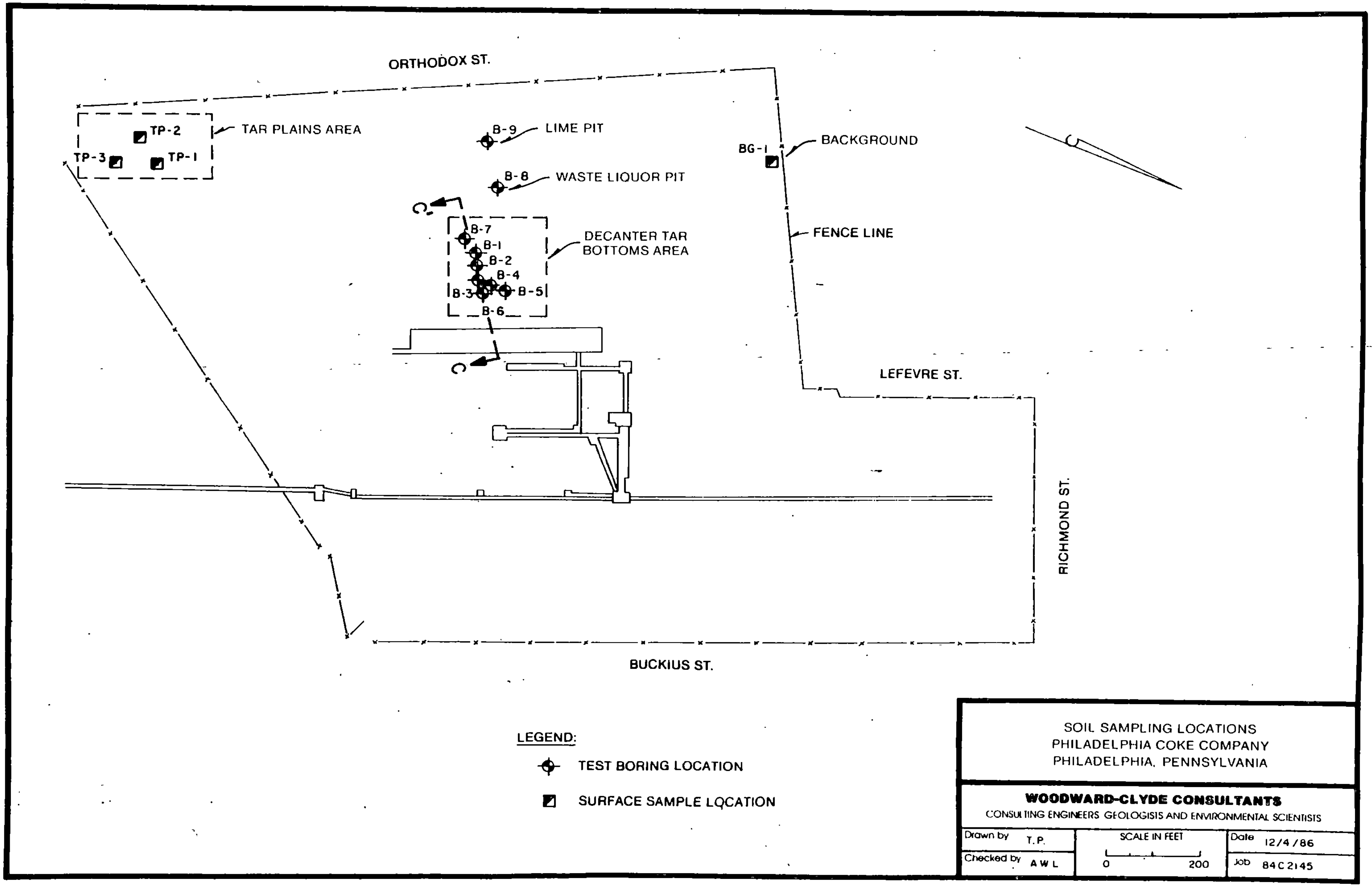
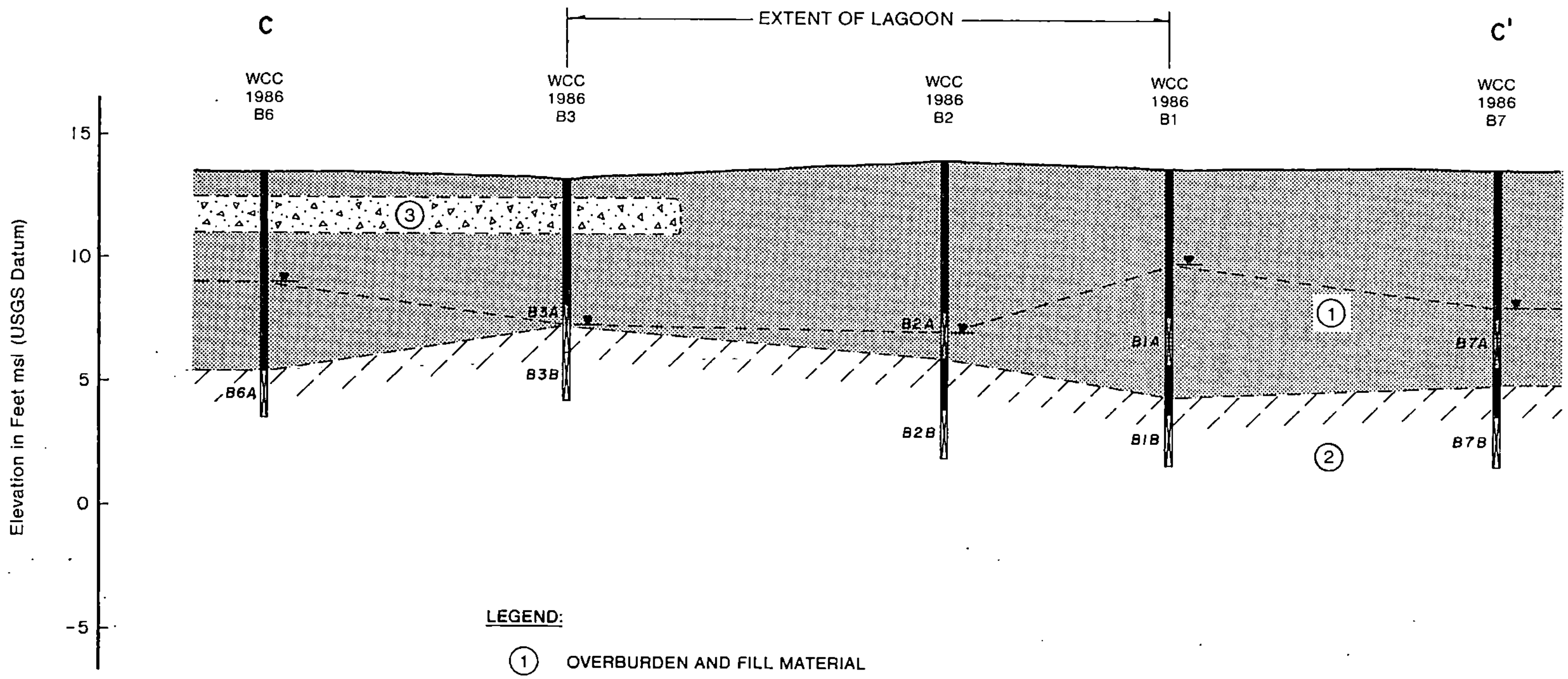

ORTHODOX ST.
TP-2
TP-3
TP-1
TAR PLAINS AREA
B-9
LIME PIT
B-8
WASTE LIQUOR PIT
BG-1
BACKGROUND
B-7
B-1
B-2
B-4
B-3
B-5
B-6
DECANTER TAR
BOTTOMS AREA
FENCE LINE
LEFEVRE ST.
RICHMOND ST.
BUCKIUS ST.
LEGEND:
TEST BORING LOCATION
SURFACE SAMPLE LOCATION
SOIL SAMPLING LOCATIONS
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
Drawn by T. P.
Checked by A W L
SCALE IN FEET
0
200
Date 12/4/86
Job 84C2145

FIGURE 5-4



LEGEND:

(1) OVERBURDEN AND FILL MATERIAL

(2) GRAY TO GRAY-BROWN SILTY CLAY

(3) CONCRETE

ESTIMATED GROUNDWATER LEVELS

TEST BORING

SOIL SAMPLE LOCATION

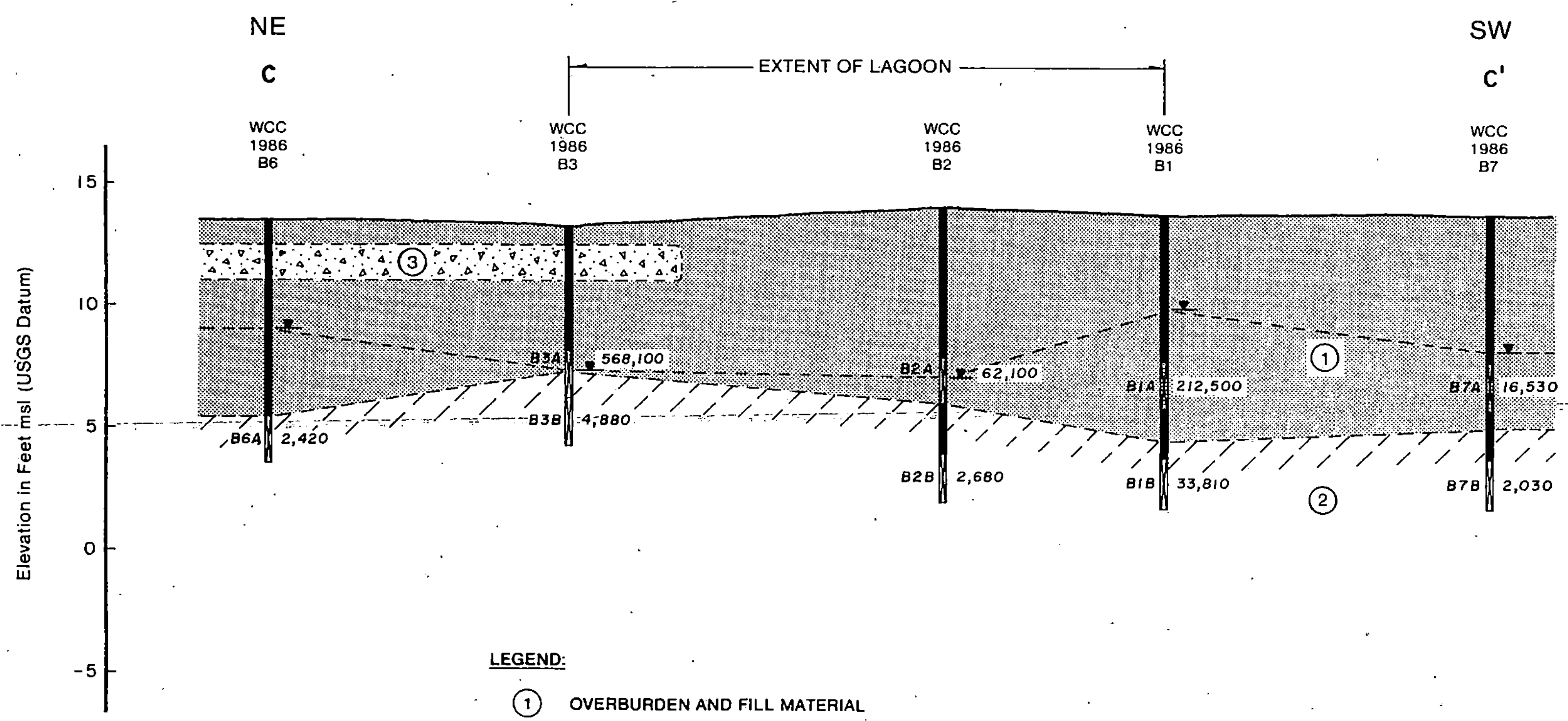
NOTE: VERTICAL EXAGGERATION x2.5

GEOLOGIC CROSS-SECTION C-C'
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: D.B.	SCALE IN FEET	Date: 12/5/86
Checked by: A.W.L.	0 — 13	Job: 84C2145

FIGURE 5-5



LEGEND:

1 OVERBURDEN AND FILL MATERIAL

2 GRAY TO GRAY-BROWN SILTY CLAY

3 CONCRETE

ESTIMATED GROUNDWATER LEVELS

TEST BORING

SOIL SAMPLE LOCATION

4,880 TOTAL BASE/NEUTRAL EXTRACTABLE CONCENTRATION IN SOIL SAMPLE

NOTE: VERTICAL EXAGGERATION x2.5

TOTAL BASE/NEUTRAL EXTRACTABLES (ppb)
DECANTER TAR BOTTOMS AREA
PHILADELPHIA COKE COMPANY
PHILADELPHIA, PENNSYLVANIA

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: D.B.	SCALE IN FEET 0 13	Date: 12/15/86
Checked by: A.W.L.		Job: 84C2145

FIGURE 5-6

Appendix A

APPENDIX A

WOODWARD-CLYDE CONSULTANTS BORING LOGS

Presented in Appendix A are the boring logs for the six monitoring wells (W-1 through W-6) installed by WCC at the Philadelphia Coke Company Plant in March 1985 and October 1986. Also, included in Appendix A are the boring logs for nine test borings (B-1 through B-9) performed during the October 1986 soil sampling program.

LOG of BORING No. B-1

DATE 10/15/86 SURFACE ELEVATION 14.18 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		29	Black coarse to fine SAND with some slag, brick fragments, little gravel, dry, dense					31
		47	- very dense					36
5		7	- some coal, concrete fragments, saturated, strong odor, oily sheen, loose					60
		15	(FILL)					37
		10		5.18				
10		3	Dark gray CLAY, some silt, very soft	2.18				
15								

Completion Depth 12 Feet Water Depth 4.3 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

WCC ... 1

LOG of BORING No. B-2

DATE 10/15/86 SURFACE ELEVATION 13.92 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		32	Black FILL, with coal, slag and brick fragments, some gravel, little silt and sand, dry, dense					15
		50						14
5		15	- with coarse to medium sand, moist, medium dense					27
		15	- saturated, bottom 3" silt some clay, oily sheen	5.92				
		4	Light and dark gray laminated SILT and CLAY, increasing clay with depth					32
10		2	- medium gray clay, some silty partings	1.92				
15								

Completion Depth 12' Feet Water Depth 6.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

WCC

LOG of BORING No. B-3

DATE 10/16/86 **SURFACE ELEVATION** 13.24 **LOCATION** See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0			Concrete	12.24				
		16	Black coarse to fine SAND, some silt, some coal and rock fragments, dry, medium dense					1
5		29	-moist	7.24				1
		8	Medium to dark gray SILT with some clay, soft, saturated					
		4	-increasing clay content with depth	4.24				
10								
15								

Completion Depth 9 Feet Water Depth 6 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

WCC .. 1

LOG of BORING No. B-4

DATE 10/16/86 SURFACE ELEVATION 15.70 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		48	Black coarse to medium SAND, coal, cement fragments, some silt, dry, very dense -concrete 20 - 32"	11.70				*
5		1 3 2	Dark gray to black fine SAND with some silt very soft (2" recovery) -saturated	6.20				
10		0	Dark to medium gray CLAY with some silt, very soft	3.70				
15			* HNU readings not taken					

Completion Depth 12 Feet Water Depth 6.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

VCC

LOG of BORING No. B-5

DATE 10/16/86 SURFACE ELEVATION 14.20 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		7	Dark gray to black SAND, some silt, brick and coal fragments, dry, loose					*
		6	-increasing coarse sand					
5		10	-dark gray to brown medium to fine sand					
		13	-with some gravel, trace clay, saturated strong odor					
		6	-black sand, some silt, oily sheen					
10		3		3.20				
			Viscous, Tar-like material	1.70				
		1	Dark to medium gray CLAY with some silt	0.20				
15								

* HNU readings not taken

Completion Depth 14 Feet Water Depth 5.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

WCC - nr 1

LOG of BORING No. B-6

DATE 10/16/86 SURFACE ELEVATION 13.50 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0			Brown coarse to medium SAND, coal fragments, some silt CONCRETE	11.00				*
	■	26	Brown to dark gray coarse to medium SAND, some silt and coal fragments, dry, dense					
5	■	10	-saturated, oily sheen, strong odor					
	■	6		5.50				
	■	5	Dark to medium gray SILT, some clay -increasing CLAY content	3.50				
10								
			* HNU readings not taken					
15								

Completion Depth 10 Feet Water Depth 4.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

LOG of BORING No. B-7

DATE 10/16/86 SURFACE ELEVATION 14.20 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		33	Brown and gray mottled coarse to medium SAND some gravel, trace clay, concrete fragments dry, very dense					*
		16	-with little coal fragments, moist strong odor					
5		8	-with slag fragments, saturated, strong odor					
		8	-some black to dark gray silt					
		4		5.20				
10		3	Medium to dark gray laminated SILT with some clay	3.20				
			Black CLAY some silt	2.20				
15			* HNU readings not taken					

Completion Depth 12 Feet Water Depth 5.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

LOG of BORING No. B-8

DATE 10/17/86 SURFACE ELEVATION 14.20 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		28	Light brown coarse to medium SAND, some silt, little gravel					2
		24	-black to dark gray sand, with some brick, coal, and concrete fragments very dense, dry					2
5		37	-some wood fragments, moist					70
		8	-saturated, oily sheen, bad odor					
		1		5.20				
10		WOH	Dark gray to black SILT and CLAY, very soft	2.20				
15								

Completion Depth 12 Feet Water Depth 6.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

LOG of BORING No. B-9

DATE 10/17/86 SURFACE ELEVATION 12.80 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		22	Black and brown coarse to fine SAND, some brick and slag fragments, dry, dense					3
		5						11
5		8	-16" layer white to light gray coarse to medium sand sized material, cemented (lime)					4
		10	-black to dark gray medium to fine sand saturated					
		5						
10			-Black medium to fine sand and silt very strong odor	2.80				
15								

Completion Depth 10 Feet Water Depth 5.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

WCC

LOG of BORING No. W-1

DATE 3/25/85 SURFACE ELEVATION 8.7 Feet LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS PPM SOILS
0		15	Black Fill. Brick, cinders, coal, medium to coarse sand, trace wood					2
		28						10
5		8		2.2				ND
		6	Dark black to gray, medium to fine sand	-0.3				<1
10		4	Very soft, gray to black clay, some silt, trace peat					58
		3						290
		5		-5.3				570
15								
20								

Completion Depth 14 Feet Water Depth 3.5 Feet Date 3/25/85

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145

Woodward-Clyde Consultants

WCC

LOG of BORING No. W-2

DATE 3/26/85 SURFACE ELEVATION 13.4 Feet LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS PPM SOILS
0								
		30						80
		17						20
5		13	Black Fill. Brick, cinders, and coal. Trace fine gravel. Bad odor					100
		14						ND
		3		3.4				ND
10								
		1	Very soft, black clay, trace silt. Bad odor					40
		WOH		-0.6				60
15								
20								

Completion Depth 14 Feet Water Depth 2.5-3 Feet Date 3/26/85
Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145

Woodward-Clyde Consultants

WCC

LOG of BORING No. W-3

DATE 3/26/85 SURFACE ELEVATION 11.5 Feet LOCATION See Plate 2

DEPTH, ft.	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS PPM SOILS
0	7	Black Fill. Coal, slag, very loose					ND
	4						ND
5	2						<1
	2		4.5				ND 18
	4	Very soft, black clay, trace silt, mica, and peat. Bad odor					880
10	2						>1000
	2	Very soft, gray to black, clayey silt, trace mica	-2.5				220
15							
20							

Completion Depth 14 Feet Water Depth 3.5 Feet Date 3/26/85

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145

Woodward-Clyde Consultants

LOG of BORING No. W-4

DATE 3/25/85 SURFACE ELEVATION 13.2 Feet LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS	PPM SOILS
0		19	Brown to black, medium to fine sand, trace coarse sand, cement. (Fill) Trace clay at 2.5'						<1
		13							ND ND
5		14	Small coal pocket at 5.5'						<1
		3							350
				4.2					
10		5	Very soft, brown clay, trace sand, trace peat and shells						520
		21		2.2					520 680
		13	Dark gray, medium sand, some gravel and clay	-1.3					220
15		9	Soft brown clay, trace sand	-2.8					160
20									

Completion Depth 16 Feet Water Depth 6 Feet Date 3/25/85

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145

Woodward-Clyde Consultants

WCC

LOG of BORING No. W-5

DATE 10/15/86 SURFACE ELEVATION 12.80 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		12	Black medium to fine SAND, some silt, little slag, moist, medium dense					0
		5	-little clay					1
5		10	-coarse to medium sand, some fine gravel					0
		10	-saturated					0
		7	-gray to brown fine sand and silt little clay	2.80				2
10		1	Medium brown to gray SILT, some clay					0
		4	-gray clay, little silt, soft					16
15		4		-3.2				1
20								

Completion Depth 16 Feet Water Depth 6.5 Feet Date 10/20/86

Project Name Philadelphia Coke Plant, Philadelphia, PA Project Number 84C2145-A

Woodward-Clyde Consultants

WCC

LOG of BORING No. W-6

DATE 10/15/86 SURFACE ELEVATION 12.90 LOCATION See Plate 2

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	HNU SOIL (ppm)
0		36	Black to brown FILL, some medium to fine sand and gravel, little silt, dry very dense					198
		45						59
5		8	-black to gray coarse to medium sand, saturated, loose					180
		12	-black and brown mottled coarse to medium sand, some gravel, little silt					20
		10		3.40				16
10		4	Gray SILT, some clay, soft					12
		3	-dark gray clay, trace silt, little peat, silt partings, soft	-1.10				14
15								
20								

Completion Depth 14 Feet Water Depth 5 Feet Date 10/20/86

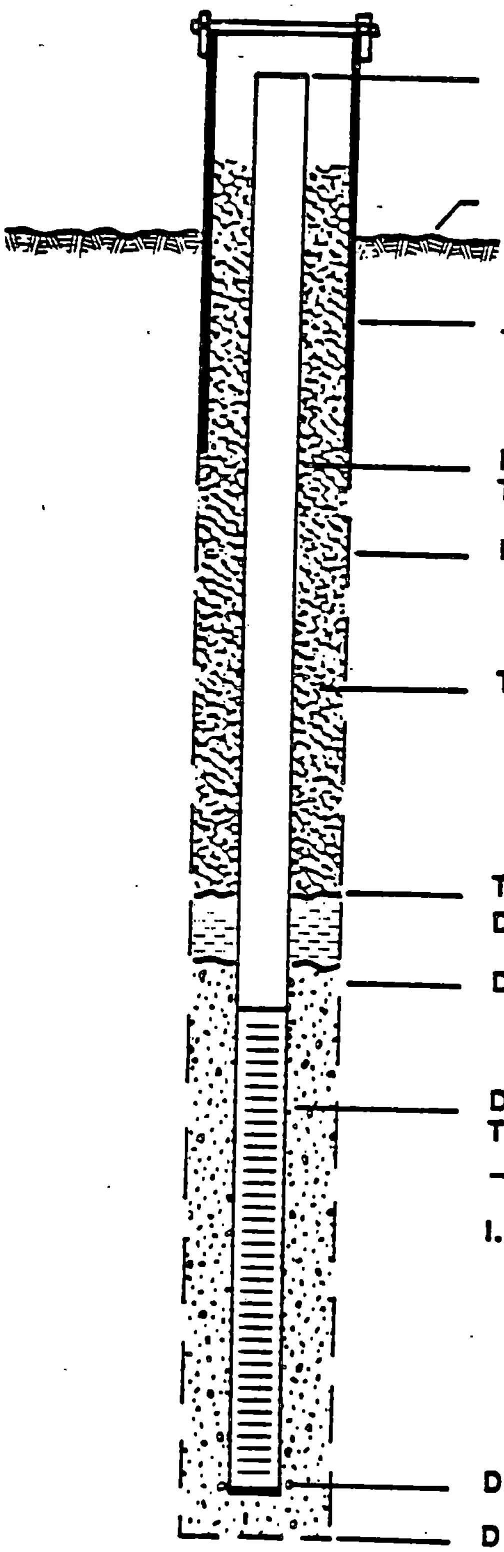
Project Name Philadelphia Coke Plant Philadelphia, PA Project Number 84C2145-A

Appendix B

APPENDIX B

WOODWARD-CLYDE CONSULTANTS MONITORING WELL REPORT

Presented in Appendix B are monitoring well reports for wells installed by WCC in March 1985 and October 1986. The reports include monitoring well design specifications of the six monitoring wells, W-1 through W-6. A summary of well construction details is provided in Table 2-1.

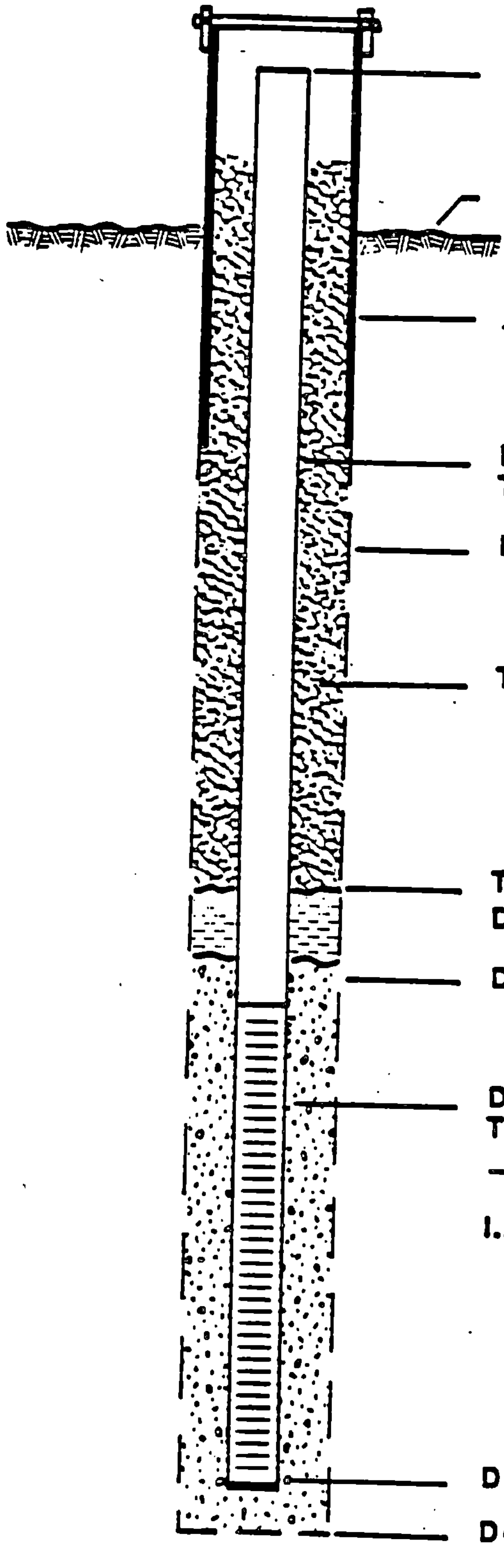


Elevation of top of riser pipe	10.94'
Ground Elevation	8.7'
I.D. of surface casing	6"
Type of surface casing	Steel with locking cap
I.D. of riser pipe	4"
Type of riser pipe	PVC
Diameter of borehole	12"
Type of backfill	cement
Type of seal	Bentonite Pellets
Depth to top of seal	1.0'
Depth to top of sand pack	2.0'
Depth to top of screen	3.0'
Type of screened section	SCH 40 20 slot PVC
I.D. of screened section	4"
Depth to bottom of well	13.0'
Depth of borehole	14.0'

REPORT OF MONITORING WELL W-1

DRAWN BY: TWT	CHECKED BY: PRJ	PROJECT NO: 84C2145	DATE: 3/25/85	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 15.31'

Ground Elevation 13.4'

I.D. of surface casing 6"
Type of surface casing Steel
with locking cap

I.D. of riser pipe 4"
Type of riser pipe PVC

Diameter of borehole 12"

Type of backfill Cement

Type of seal Bentonite Pellets
Depth to top of seal 1.0'

Depth to top of sand pack 2.0'

Depth to top of screen 3.0'
Type of screened section
SCH 40 20 slot PVC

I.D. of screened section 4"

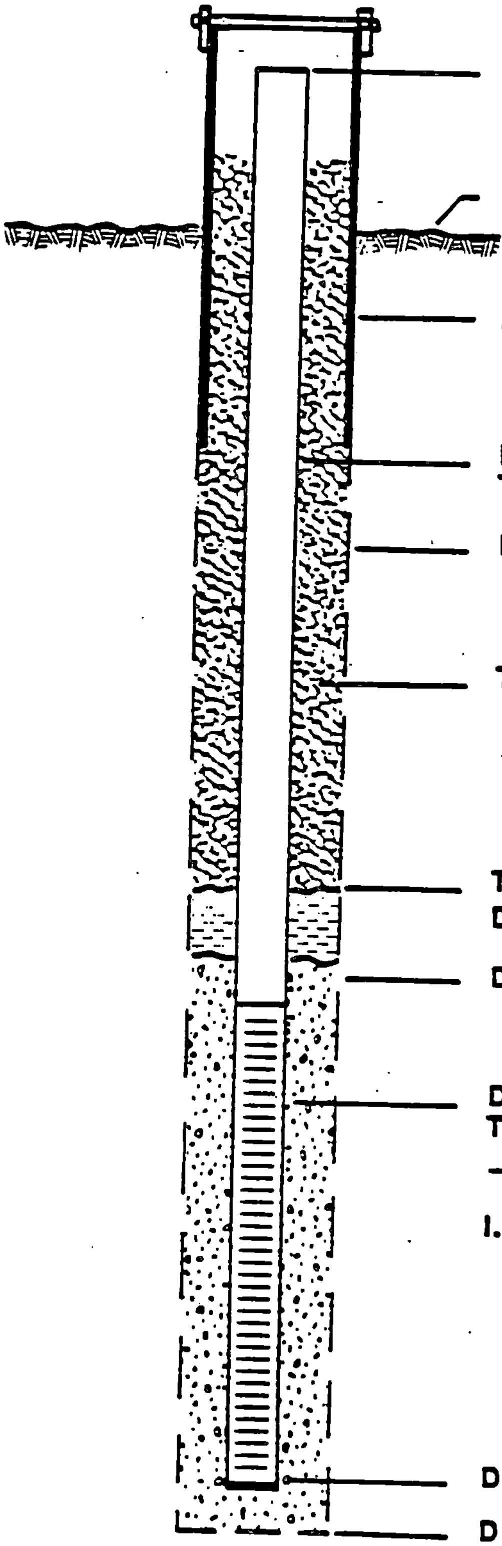
Depth to bottom of well 13.0'

Depth of borehole 14.0'

REPORT OF MONITORING WELL W-2

DRAWN BY: TWT	CHECKED BY: PRJ	PROJECT NO: 84C2145	DATE: 3/26/85	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 14.46'

Ground Elevation 11.5'

I.D. of surface casing 6"
Type of surface casing Steel
with locking cap

I.D. of riser pipe 4"
Type of riser pipe PVC

Diameter of borehole 12"

Type of backfill Cement

Type of seal Bentonite Pellets
Depth to top of seal 1.0'

Depth to top of sand pack 2.0'

Depth to top of screen 2.5'
Type of screened section
SCH 40 20 slot PVC

I.D. of screened section 4"

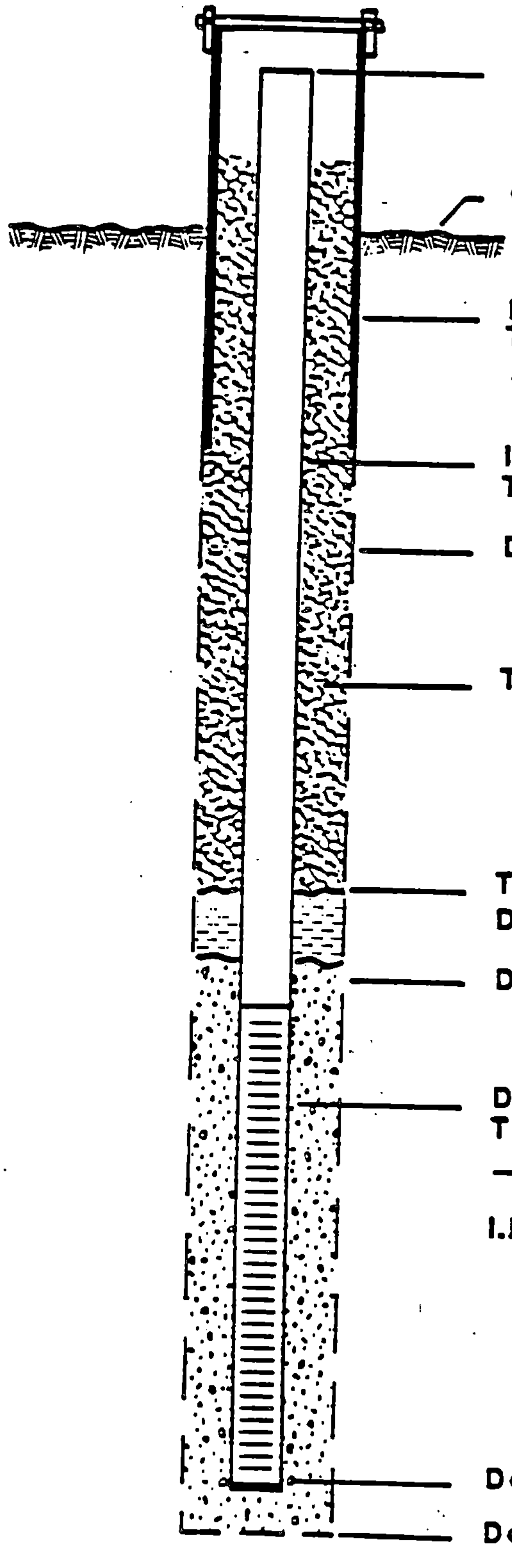
Depth to bottom of well 12.5'

Depth of borehole 14.0'

REPORT OF MONITORING WELL W-3

DRAWN BY: TWT	CHECKED BY: PRJ	PROJECT NO: 84C2145	DATE: 3/26/85	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe: 15.17'

Ground Elevation: 13.2'

I.D. of surface casing: 6"

Type of surface casing: Steel with locking cap

I.D. of riser pipe: 4"

Type of riser pipe: PVC

Diameter of borehole: 12"

Type of backfill: Cement

Type of seal: Bentonite Pellets

Depth to top of seal: 2.0'

Depth to top of sand pack: 3.0'

Depth to top of screen: 4.0'

Type of screened section: SCH 40 20 slot PVC

I.D. of screened section: 4"

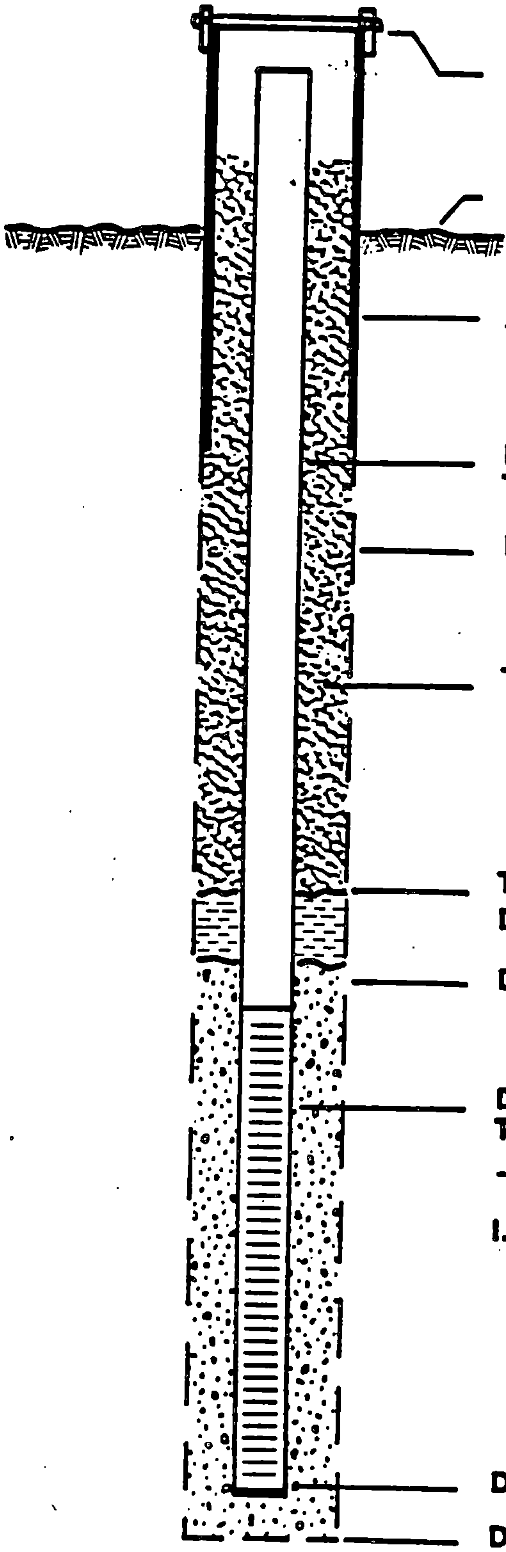
Depth to bottom of well: 14.0'

Depth of borehole: 16.0'

REPORT OF MONITORING WELL W-4

DRAWN BY: TWT	CHECKED BY: PRJ	PROJECT NO: 84C2145	DATE: 3/25/85	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 14.76

Ground Elevation 12.80

I.D. of surface casing 4"
Type of surface casing steel
with locking cap

I.D. of riser pipe 2"
Type of riser pipe PVC

Diameter of borehole 8"

Type of backfill cement

Type of seal Bentonite Pellets
Depth to top of seal 2.5'

Depth to top of sand pack 3.0'

Depth to top of screen 4.0'
Type of screened section
SCH 40 10 slot PVC

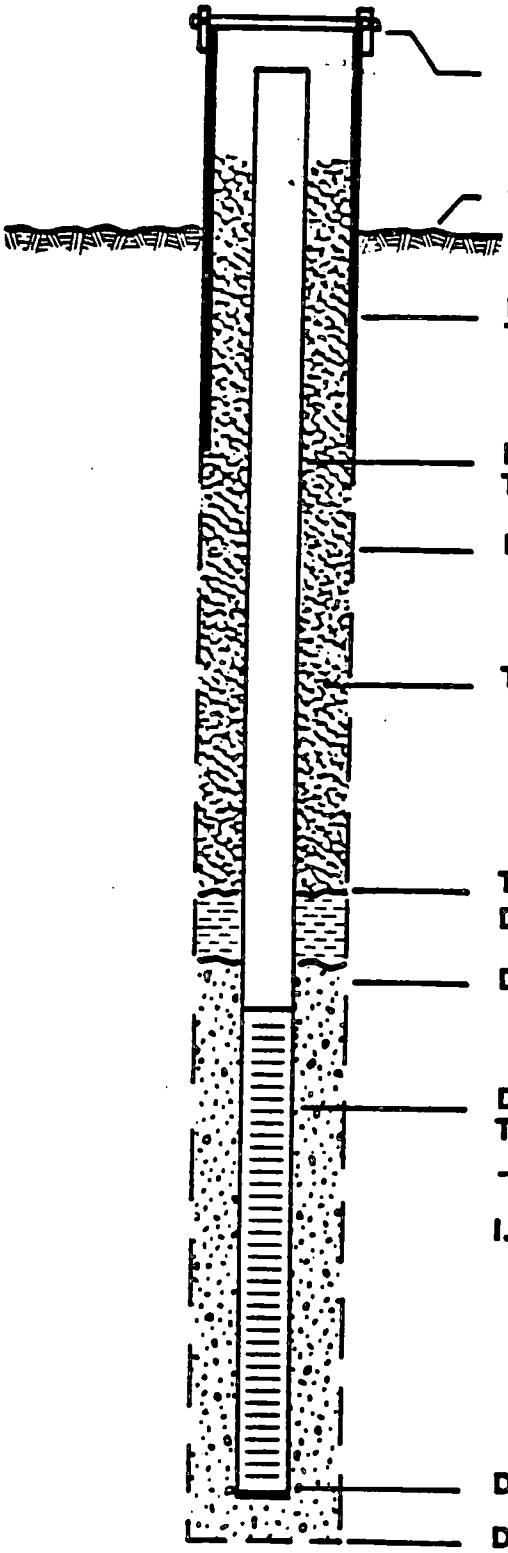
I.D. of screened section 2"

Depth to bottom of well 14.0'
Depth of borehole 16.0'

REPORT OF MONITORING WELL W-5

DRAWN BY: TP	CHECKED BY: RG	PROJECT NO: 84C2145-A	DATE: 10/23/86	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe: 14.50

Ground Elevation: 12.90

I.D. of surface casing: 4"
Type of surface casing: steel with locking cap

I.D. of riser pipe: 2"
Type of riser pipe: PVC

Diameter of borehole: 8"

Type of backfill: cement

Type of seal: Bentonite Pellets
Depth to top of seal: 2.5'

Depth to top of sand pack: 3.0'

Depth to top of screen: 4.0'
Type of screened section: SCH 40 10 slot PVC

I.D. of screened section: 2"

Depth to bottom of well: 14.0'
Depth of borehole: 14.0'

REPORT OF MONITORING WELL W-6

DRAWN BY: TP	CHECKED BY: RG	PROJECT NO: 84C2145-A	DATE: 10/23/86	FIGURE NO:

Woodward-Clyde Consultants